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87271R03

DESIGN ANALYSIS NOTEBOOK

FOR

INTERIM ACTION
ROCKY MOUNTAIN ARSENAL
BASIN F

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Rocky Mountain Arsenal
Information Center
Commerce City, Colorado

July, 1987

Submitted to: U.S. Army Corps of Engineers
Omaha District

Submitted by: Woodward-Clyde Consultants
In Association with
HDR Infrastructure, Inc.
A Centerra Company

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DENVER, CO

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13. ABSTRACT *(Maximum 200 words)*

THIS NOTEBOOK CONCERNING THE INTERIM BASIN F LANDFILL CONTAINS:
1. NARRATIVE INFORMATION,
2. HAND WRITTEN SPECIFICATIONS
3. COMPUTATIONS CHARTS
4. DATA
5. DRAWINGS
6. MAPS
7. BROCHURES
8. CORRESPONDENCE.

AREAS COVERED INCLUDE:
1. SOIL/LANDFILL STRENGTH-STABILITY ANALYSIS
2. CURL DESIGN
3. CONTAMINATED LIQUID REMOVAL
4. MATERIAL ABSORPTION.

14. SUBJECT TERMS
TREATMENT, EQUIPMENT, LINERS

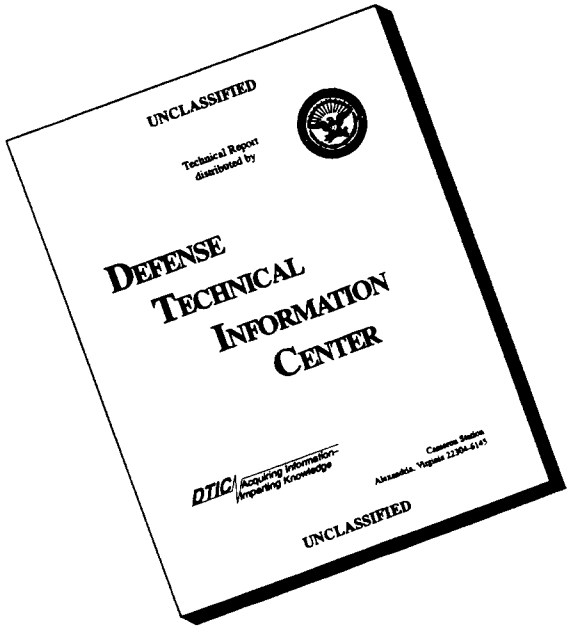
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Stanford Place 3, Suite 1000
4582 South Ulster Street Parkway
Denver, Colorado 80237
(303) 694-2770
Telex 501285 (WOODWARD DVR)

Woodward-Clyde Consultants

July 17, 1987

Department of the Army
Omaha District, Corps of Engineers
Attn: MROED-B/Wilson
215 North 17th Street
Omaha, NE 68102-4910

Re: Design Analysis Notebook, Basin F, Rocky Mountain Arsenal, Colorado
Project No. 86C8554P (T002) (21947)

Gentlemen:

Enclosed for your review are 5 copies of our Design Analyses Notebook for the above-referenced project. In addition to this documentation, support for the criteria and alternatives selected for design can be found in the minutes of the 30% and 60% review meetings.

During the course of our design work, we have been directed by the Corps of Engineers and Rocky Mountain Arsenal project representatives to depart from the original design concept which was to design the facilities to meet RCRA requirements of 40 CFR and the draft "Minimum Technology for Guidance on Double Liner Systems for Landfills and Surface Impoundments." We wish to emphasize that the design criteria and alternatives that have been adopted for the Basin F Interim Action depart significantly from this original direction and many of the back-up systems normally included in a design meeting RCRA requirements are absent from the current design.

As you know, the leak detection system and backup layers of synthetic and clay liners have been deleted from the design at your direction. It is a well known and commonly accepted fact that all liners leak to some degree. Because back-up systems such as a secondary synthetic liner, leak detection system and compacted clay liner have not been included in the design of this interim facility, some leakage through the liner will probably occur and the magnitude of leakage through the liner will be unknown. To reduce the amount of environmental contamination during the five year service life of the waste pile and surface impoundment facilities, we recommend stringent adherence to quality control standards and extreme care in the installation of the synthetic lining systems.

If you have questions, please call.

Sincerely,

James R. Obermeyer

James R. Obermeyer
Project Manager

DJH:ljh (LJH/le21947-2)

(5 copies sent)

3c: Ali Alavi, COE - Aberdeen, Maryland
1c: Bruce Larsen, HDR - Omaha
1c: Ken Nass, WCC - Omaha
1c: Binder

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SOIL/LANDFILL STRENGTH-STABILITY ANALYSIS

DATE

JOB NO.

PAGE NO.

WASTE LANDFILL STABILITY

Slope Stability Analyses Performed By Connie Bohn

Checked By: RSJ (Robert Junkins)

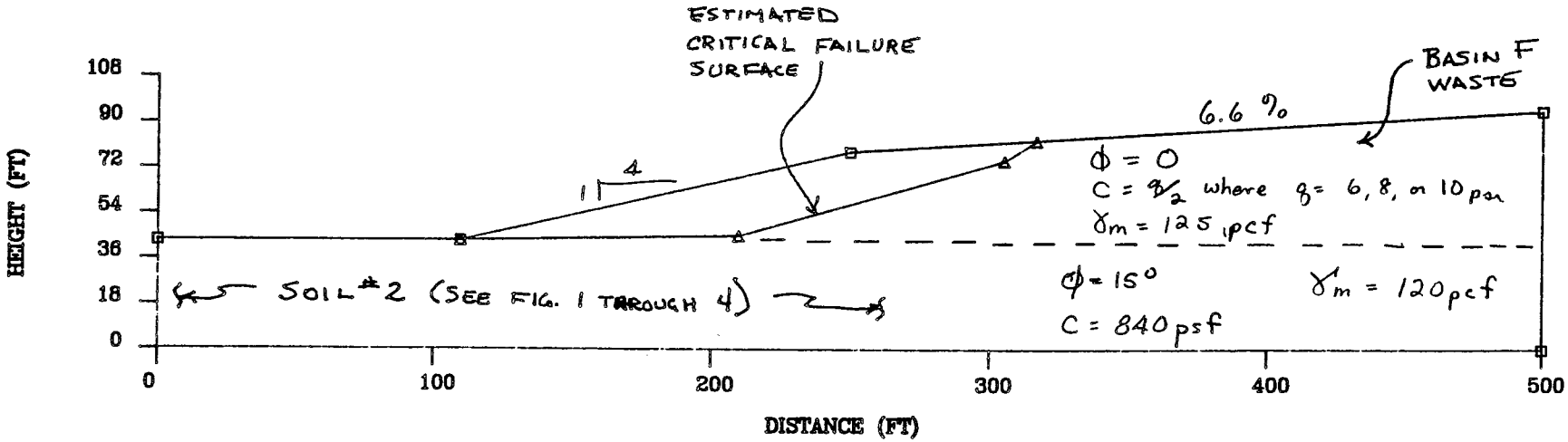
BRL

* COMPRESSIVE STRENGTH VALUES WILL BE SPECIFIED IN CONTRACT DOCUMENTS AND CONTROLLED BY THE CONTRACTOR. A MINIMUM COMPRESSIVE STRENGTH OF 10 psi WAS CHOSEN SO THAT AN ESTIMATED MINIMUM FACTOR OF SAFETY OF 2 WOULD BE AVAILABLE WITH REGARD TO SLOPE STABILITY DURING CONSTRUCTION OF THE WASTE PILE.

ROCKY MOUNTAIN ARSENAL
WASTE LANDFILL
WOODWARD–CLYDE CONSULTANTS

q^* (psi)	F. S.
6	1.36
8	1.65
10	2.06

→ SPECIFY $q = 10$ psi in contract documents.



□ GROUND SURFACE △ CRIT. CIRCLE FS

SLOPE STABILITY ANALYSIS FOR ROCKY MT. ARSENAL

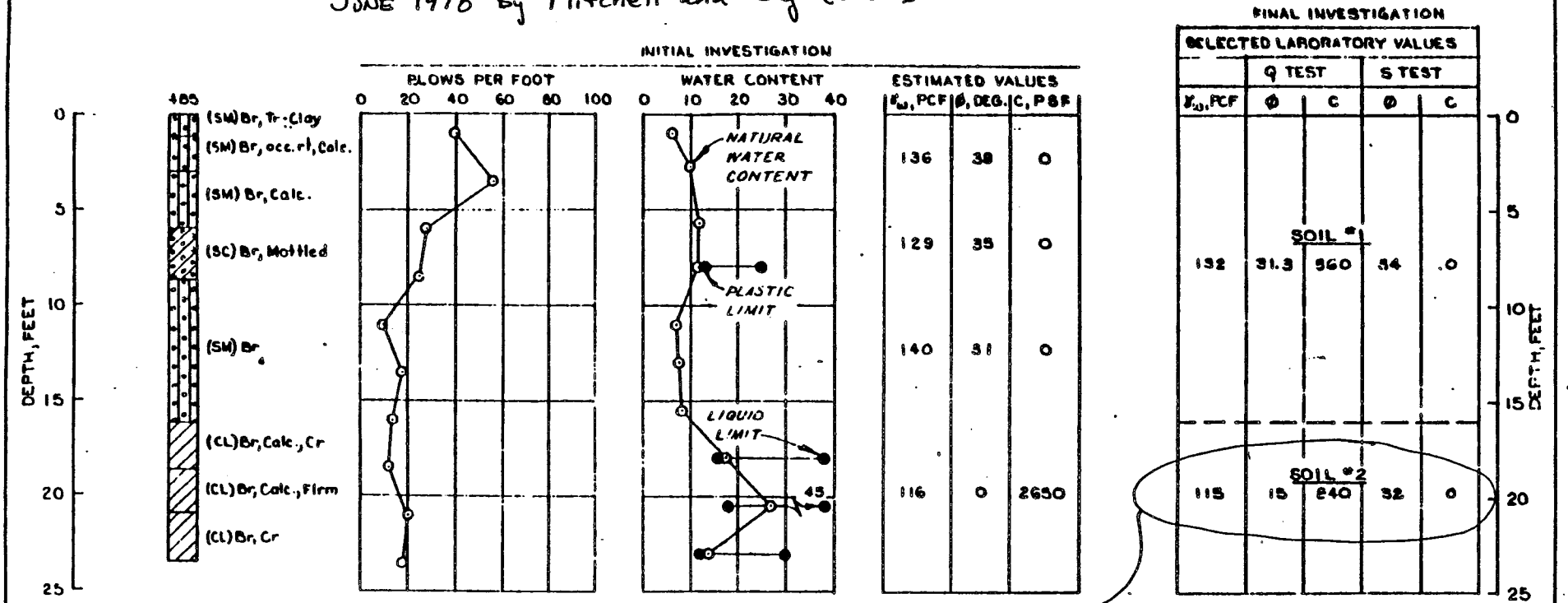
DATE

JOB NO.

PAGE NO.

SOIL STRENGTH PARAMETERS

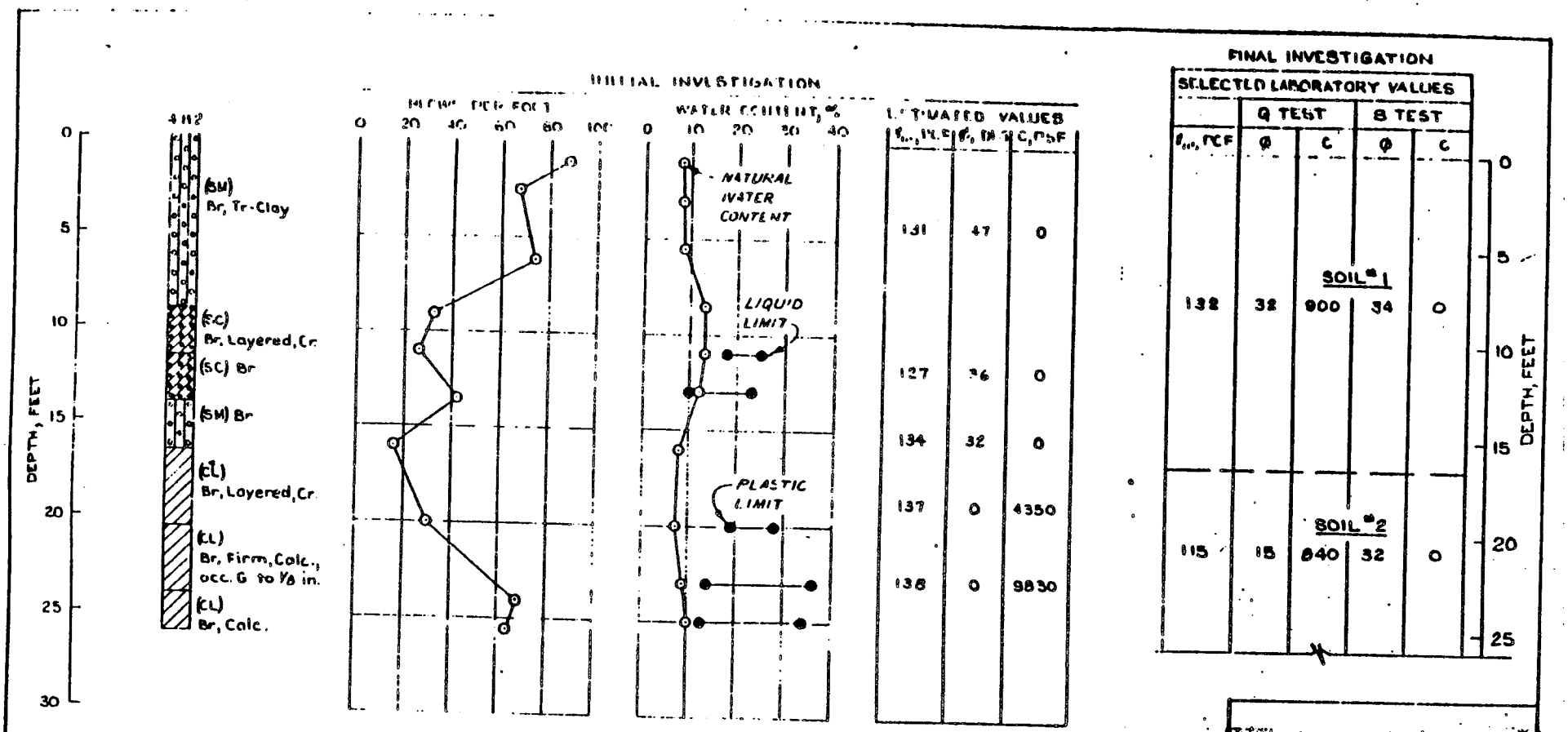
REFERENCE: DIKE STABILITY ANALYSIS, BASIN F, ROCKY MOUNTAIN ARSENAL, DENVER, CO. JUNE 1978 by Mitchell and Jeng (WES)



NOTE: THIS MATERIAL WAS ASSUMED BENEATH THE WASTE PILE DURING CONSTRUCTION. THE BORINGS SHOWN HERE WERE LOCATED IN THE BASIN F EXTERIOR DIKE SYSTEM AND MATERIALS WERE TESTED AND PROPERTIES OF SOILS ESTIMATED BY THE WATERWAYS EXPERIMENT STATION VICKSBURG, MISSISSIPPI.

GRAPHIC BORING LOGS & STRENGTH VALUES
DIKE STABILITY ANALYSIS
BASIN F
ROCKY MOUNTAIN ARSENAL
DENVER, COLORADO

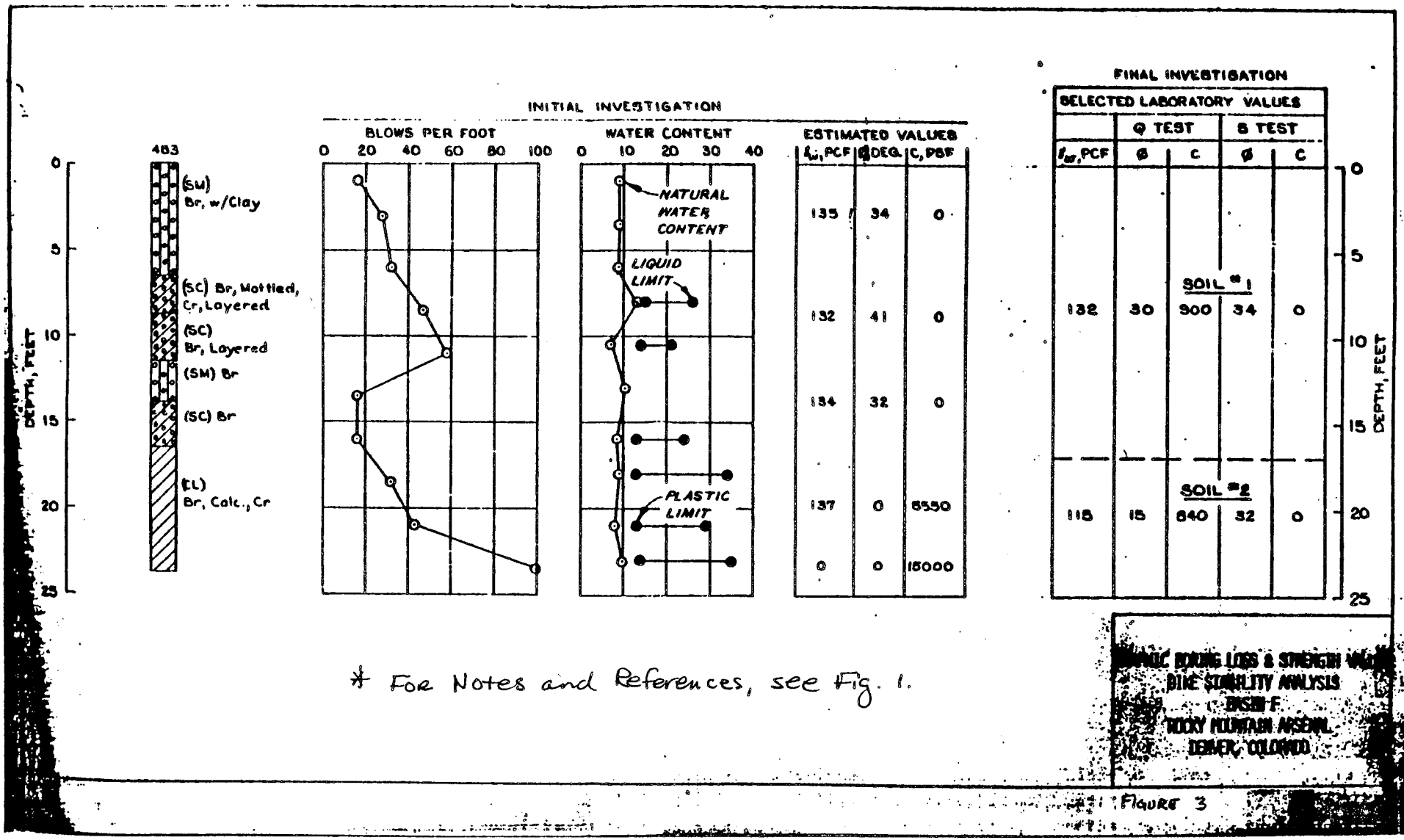
FIGURE 1



* For Notes and Reference, see Fig. 1.

GRAPHIC BORING LOGS & STRENGTH VALUES
DIKE STABILITY ANALYSIS
BASIN F
ROCKY MOUNTAIN ARSENAL
DENVER, COLORADO

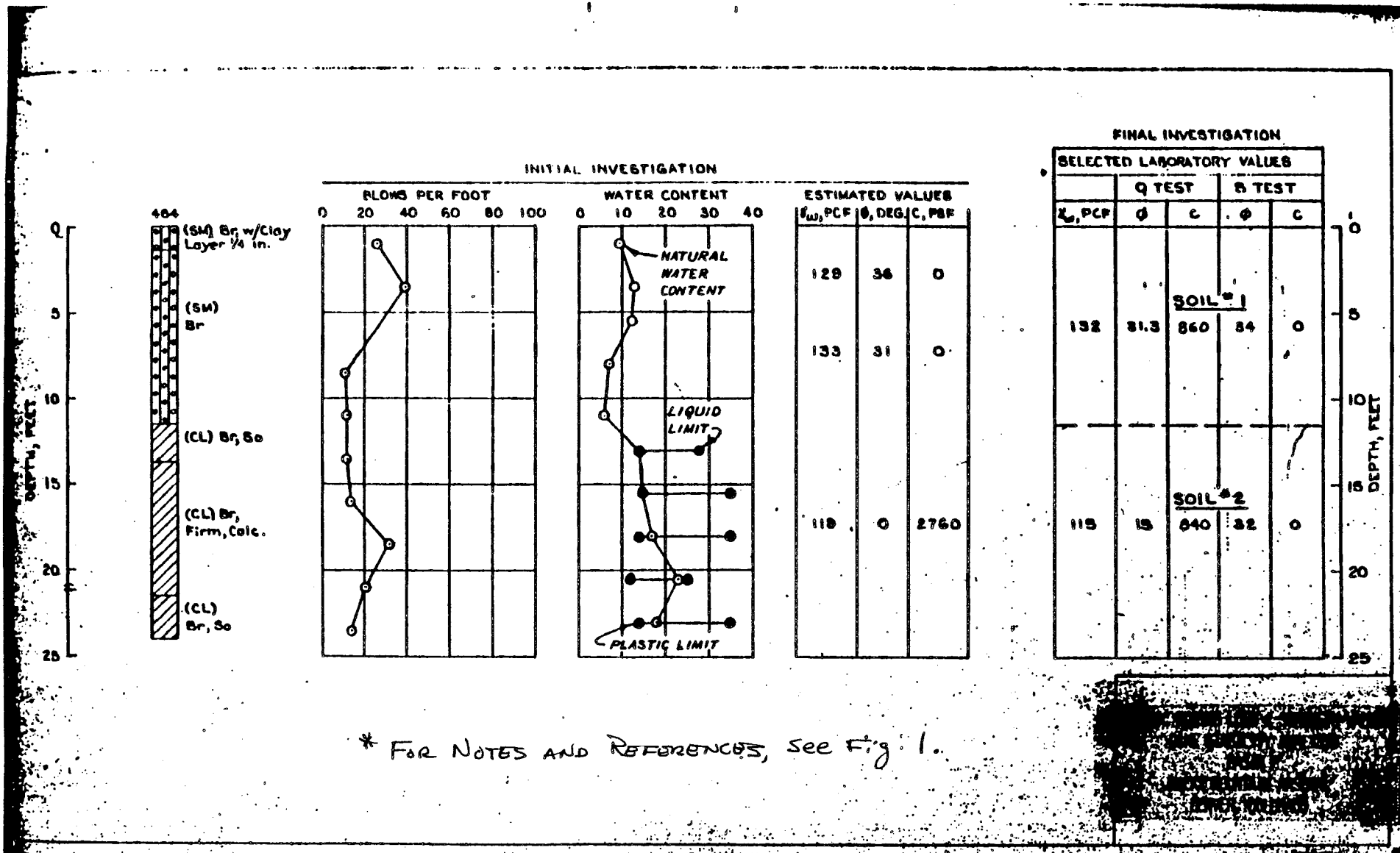
FIGURE 2



* For Notes and References, see Fig. 1.

SEISMIC BORING LOGS & STRENGTH VALUES
DIKE STABILITY ANALYSIS
BASIN F
ROCKY MOUNTAIN ARSENAL
DENVER, COLORADO

FIGURE 3



* For Notes and References, see Fig. 1.

FIGURE 4

DATE

JOB NO.

PAGE NO.

WASTE LANDFILL STABILITY ANALYSES

$q = 6$ psi

Slope Stability Analyses Performed By Connie Bohn

Checked By: RSJ

BRL

WASTE
LANDFILL

6 psi

** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	4-7-87
Time of Run:	10:30
Run By:	CB
Input Data Filename:	RMA-T1
Output Filename:	RMA-T1.OUT

PROBLEM DESCRIPTION ROCKY MOUNTAIN ARSENAL - TRIAL 1

BOUNDARY COORDINATES

3 Top Boundaries
4 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	43.00	110.00	43.00	2
2	110.00	43.00	250.00	78.00	1
3	250.00	78.00	500.00	94.50	1
4	110.00	43.00	500.00	43.00	2

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Pie Surfa No.
1	125.0	125.0	432.0	.0	.00	.0	1
2	120.0	120.0	840.0	15.0	.00	.0	1

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

250 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 25 Points Equally Spaced

Along The Ground Surface Between X = 10.00 ft.
and X = 250.00 ft.

Each Surface Terminates Between X = 260.00 ft.
and X = 490.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

100.00 ft. Line Segments Define Each Trial Failure Surface.

**** ERROR - RC11 ****

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	110.00	43.00
2	209.98	44.81
3	305.47	74.52
4	317.44	82.45

*** 1.362 ***

Failure Surface Specified By 3 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	140.00	50.50
2	240.00	50.15
3	292.74	80.82

*** 1.448 ***

1

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	130.00	48.00
2	229.80	41.67
3	326.78	66.07
4	357.36	85.09

*** 1.659 ***

Failure Surface Specified By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	110.00	43.00
2	209.94	46.48
3	309.39	56.97
4	407.86	74.41
5	483.74	93.43

*** 1.703 ***

1

Failure Surface Specified By 3 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	130.00	48.00
2	229.73	40.63
3	283.37	80.20

*** 1.815 ***

Failure Surface Specified By 3 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	120.00	45.50
2	219.90	41.00
3	291.35	80.73

*** 1.953 ***

1

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.00	53.00

2	250.00	52.90
3	349.08	66.47
4	433.37	90.10

*** 1.997 ***

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	130.00	48.00
2	229.61	39.22
3	327.23	60.93
4	370.32	85.94

*** 2.039 ***

1

Failure Surface Specified By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	130.00	48.00
2	229.11	34.66
3	319.66	77.10
4	323.25	82.83

*** 2.262 ***

Failure Surface Specified By 5 Coordinate Points

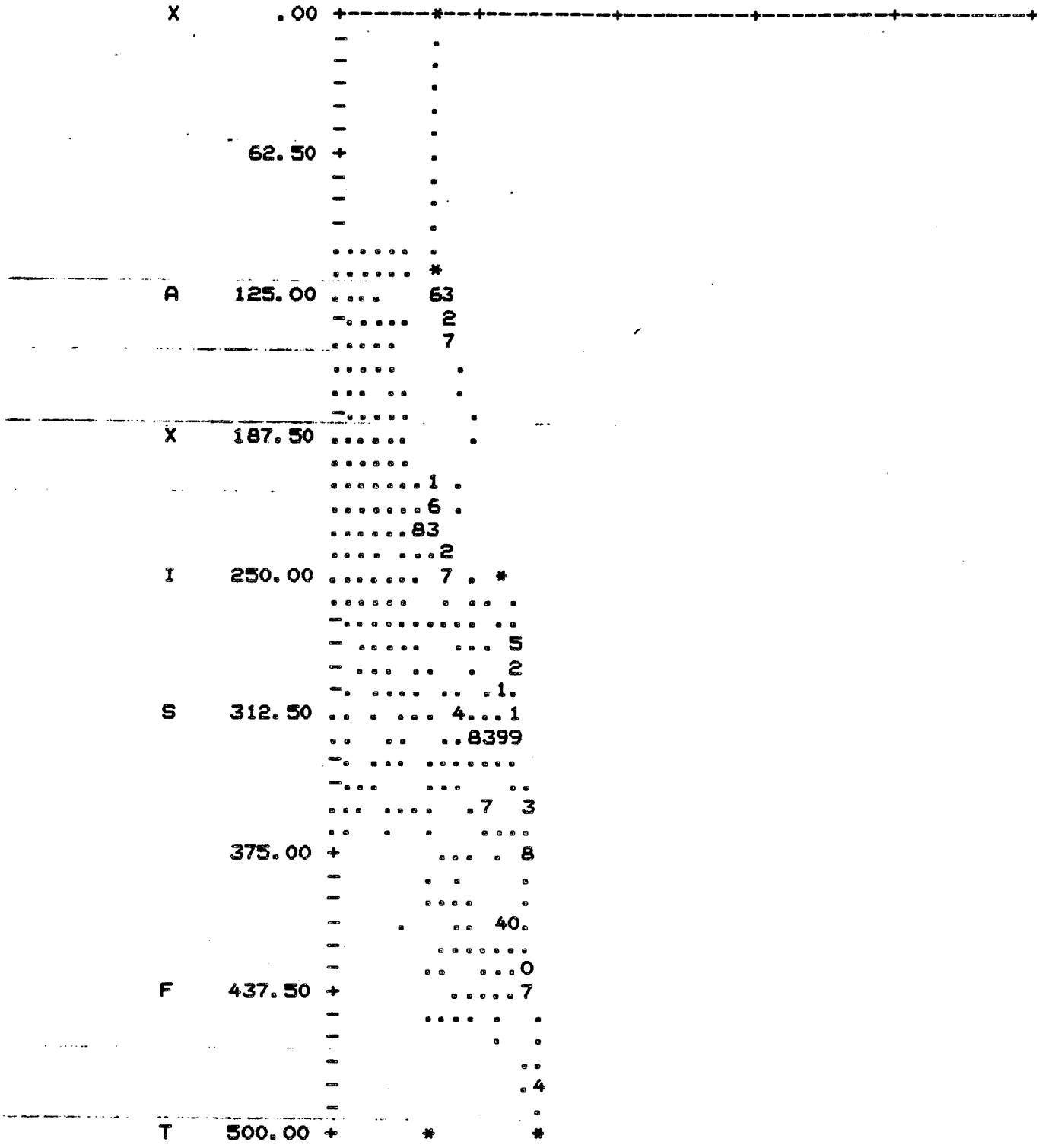
Point No.	X-Surf (ft)	Y-Surf (ft)
1	110.00	43.00
2	209.98	40.86
3	309.17	53.56
4	405.39	80.80
5	424.70	89.53

*** 2.301 ***

1

Y A X I S F T

.00 62.50 125.00 187.50 250.00 312.5(


X
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312.50
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F
437.50
T
500.00

DATE

JOB NO.

PAGE NO.

WASTE LANDFILL

STABILITY ANALYSES

$q = 8$ psi

** PCSTABL5 **

by
Purdue University

8psf

1

--Slope Stability Analysis--
Simpl fied Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	4-8-87
Time of Run:	16:45
Run By:	CB
Input Data Filename:	RMA-T1
Output Filename:	RMA-T1.OUT

PROBLEM DESCRIPTION ROCKY MOUNTAIN ARSENAL - TRIAL 1

BOUNDARY COORDINATES

3 Top Boundaries
4 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	43.00	310.00	43.00	2
2	310.00	43.00	450.00	78.00	1
3	450.00	78.00	700.00	94.50	1
4	310.00	43.00	700.00	43.00	2

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
1	125.0	125.0	576.0	.0	.00	.0	1
2	120.0	120.0	840.0	15.0	.00	.0	1

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

250 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 25 Points Equally Spaced

Along The Ground Surface Between X = 150.00 ft.
and X = 450.00 ft.

Each Surface Terminates Between X = 455.00 ft.
and X = 700.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

25.00 ft. Line Segments Define Each Trial Failure Surface.

**** ERROR - RC11 ****

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	362.50	56.13
2	385.95	47.46
3	410.91	45.94
4	435.24	51.69
5	456.87	64.22
6	471.08	79.39

*** 1.647 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	362.50	56.13
2	386.56	49.33
3	411.43	46.77
4	436.37	48.53
5	460.63	54.54
6	483.51	64.63
7	504.30	78.50
8	507.78	81.81

*** 1.724 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	350.00	53.00
2	373.70	45.04
3	398.53	42.11
4	423.43	44.33
5	447.34	51.61
6	469.26	63.64
7	488.24	79.91
8	488.74	80.56

*** 1.741 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	337.50	49.88
2	362.26	46.45
3	387.26	45.87
4	412.15	48.16
5	436.62	53.29
6	460.34	61.18
7	483.01	71.73
8	498.44	81.20

*** 1.765 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	375.00	59.25
2	398.66	51.18
3	423.54	48.71
4	448.32	51.99
5	471.70	60.84
6	492.45	74.79
7	498.40	81.19

*** 1.848 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	362.50	56.13
2	386.98	51.07
3	411.94	49.66
4	436.84	51.94
5	461.13	57.86
6	484.29	67.28
7	505.81	80.00
8	508.06	81.83

*** 1.930 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	387.50	62.38
2	410.29	52.09
3	434.97	48.15
4	459.83	50.83
5	483.11	59.93
6	503.19	74.83
7	508.73	81.88

*** 1.971 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	350.00	53.00
2	374.77	49.64
3	399.68	47.46
4	424.66	46.46
5	449.66	46.66
6	474.62	48.04
7	499.49	50.61
8	524.20	54.36
9	548.72	59.27
10	572.97	65.35
11	596.90	72.58
12	620.46	80.93
13	643.60	90.40
14	644.56	90.84

*** 1.989 ***

1

Failure Surface Specified By 14 Coordinate Points

Point	X-Surf	Y-Surf

No.	(ft)	(ft)
1	375.00	59.25
2	399.34	53.54
3	423.98	49.29
4	448.82	46.52
5	473.79	45.23
6	498.79	45.44
7	523.73	47.14
8	548.53	50.32
9	573.09	54.98
10	597.33	61.10
11	621.16	68.65
12	644.50	77.61
13	667.26	87.95
14	676.76	92.97

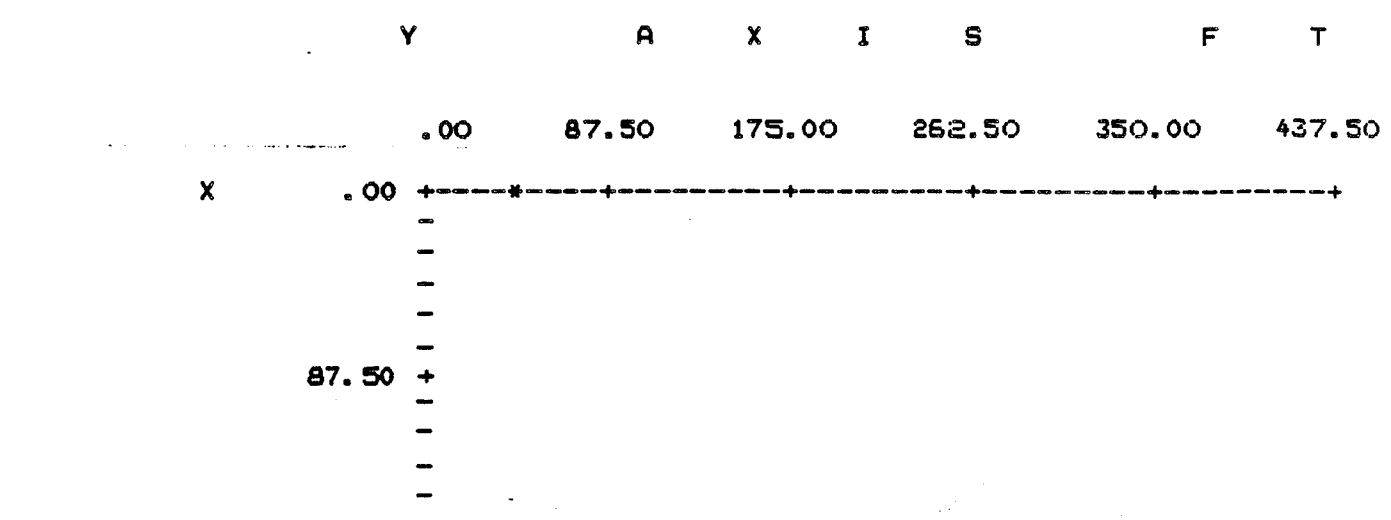
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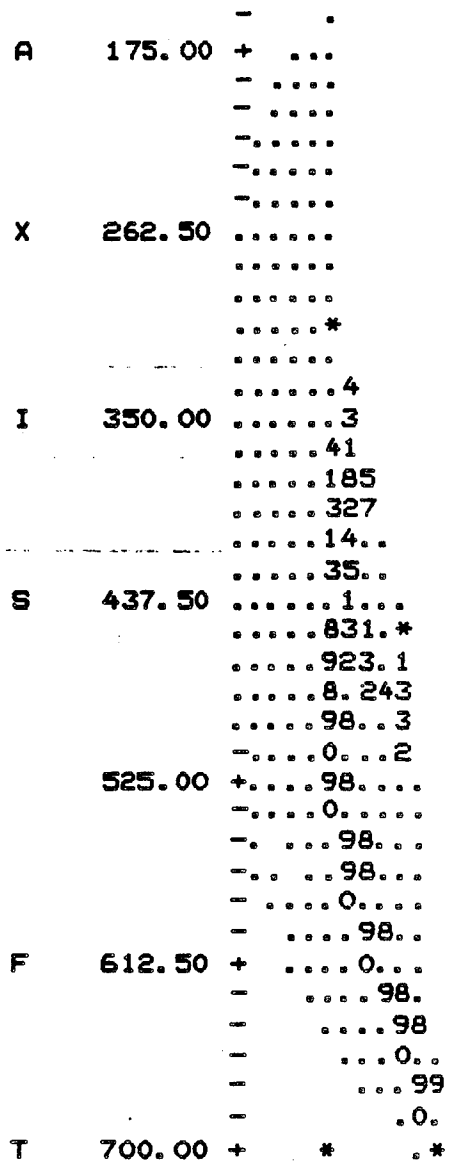
Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	387.50	62.38
2	411.75	56.30
3	436.32	51.68
4	461.12	48.52
5	486.06	46.83
6	511.06	46.63
7	536.03	47.90
8	560.88	50.65
9	585.52	54.87
10	609.87	60.53
11	633.84	67.63
12	657.35	76.14
13	680.31	86.03
14	696.75	94.29

*** 2.251 ***

1




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175.00
X
262.50
I
350.00
S
437.50
525.00
F
612.50
T
700.00

DATE

JOB NO.

PAGE NO.

WASTE LANDFILL

STABILITY ANALYSES

$q = 10$ psi

** PCSTABL5 **

by
Purdue University

10 psf

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	4-8-87
Time of Run:	16:50
Run By:	CB
Input Data Filename:	RMA-T1
Output Filename:	RMA-T1.OUT

PROBLEM DESCRIPTION ROCKY MOUNTAIN ARSENAL - TRIAL 1

BOUNDARY COORDINATES

3 Top Boundaries
4 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	43.00	310.00	43.00	2
2	310.00	43.00	450.00	78.00	1
3	450.00	78.00	700.00	94.50	1
4	310.00	43.00	700.00	43.00	2

1

ISOTROPIC SOIL PARAMETERS

2 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surfac No.
1	125.0	125.0	720.0	.0	.00	.0	1
2	120.0	120.0	840.0	15.0	.00	.0	1

1

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and X = 700.00 ft.

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3	410.91	45.94
4	435.24	51.69
5	456.87	64.22
6	471.08	79.39

*** 2.059 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	350.00	53.00
2	373.70	45.04
3	398.53	42.11
4	423.43	44.33
5	447.34	51.61
6	469.26	63.64
7	488.24	79.91
8	488.74	80.56

*** 2.068 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	362.50	56.13
2	386.56	49.33
3	411.43	46.77
4	436.37	48.53
5	460.63	54.54
6	483.51	64.63
7	504.30	78.50
8	507.78	81.81

*** 2.154 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	337.50	49.88
2	362.26	46.45
3	387.26	45.87
4	412.15	48.16
5	436.62	53.29
6	460.34	61.18
7	483.01	71.73
8	498.44	81.20

*** 2.206 ***

1

Failure Surface Specified By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	375.00	59.25
2	398.66	51.18
3	423.54	48.71
4	448.32	51.99
5	471.70	60.84
6	492.45	74.79
7	498.40	81.19

*** 2.311 ***

Failure Surface Specified By 8 Coordinate Points

Point	X-Surf	Y-Surf

1	362.50	56.13
2	386.98	51.07
3	411.94	49.66
4	436.84	51.94
5	461.13	57.86
6	484.29	67.28
7	505.81	80.00
8	508.06	81.83

*** 2.413 ***

1

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	287.50	43.00
2	308.22	29.01
3	331.24	19.26
4	355.71	14.13
5	380.71	13.79
6	405.30	18.27
7	428.57	27.40
8	449.66	40.83
9	467.77	58.07
10	482.22	78.47
11	482.99	80.18

*** 2.418 ***

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	312.50	43.63
2	334.16	31.14
3	358.25	24.46
4	383.25	24.02
5	407.56	29.83
6	429.65	41.54
7	448.11	58.40
8	461.40	78.75

*** 2.439 ***

1

Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	287.50	43.00
2	309.55	31.23
3	333.44	23.85
4	358.30	21.15
5	383.21	23.20
6	407.28	29.95
7	429.64	41.15
8	449.46	56.38
9	466.03	75.10
10	468.46	79.22

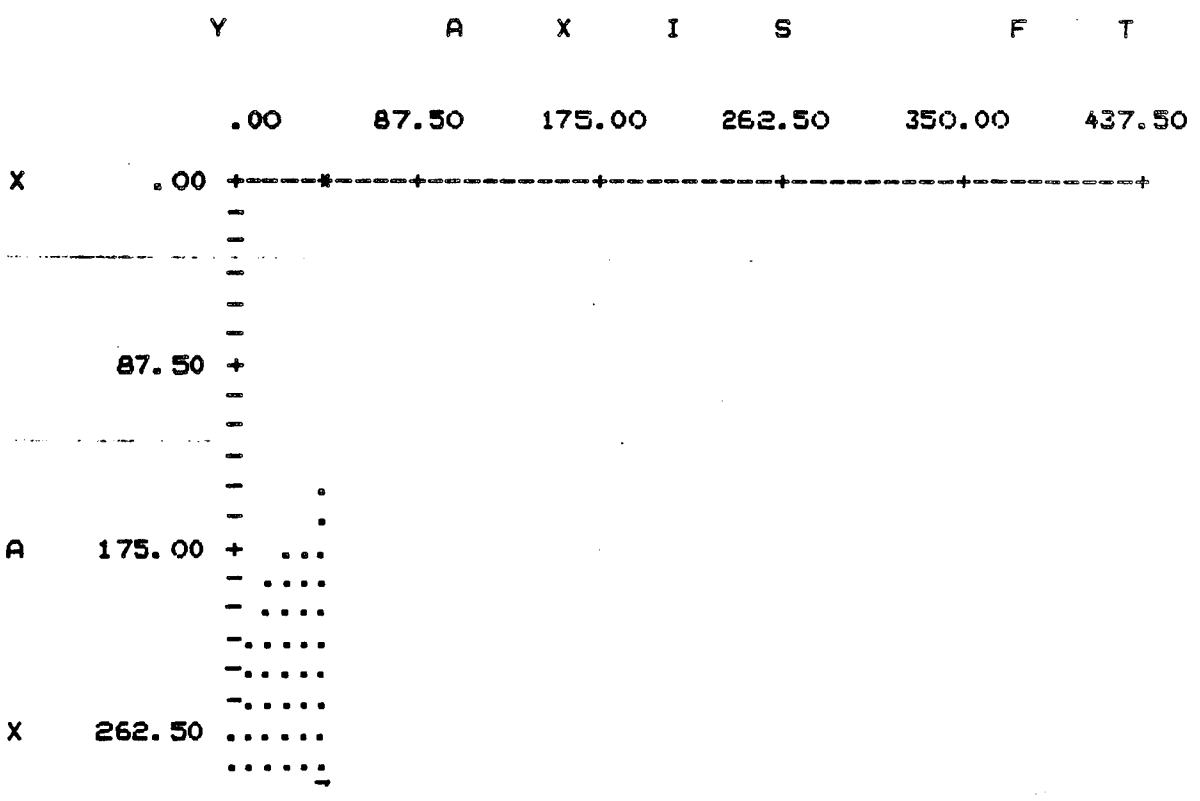
*** 2.446 ***

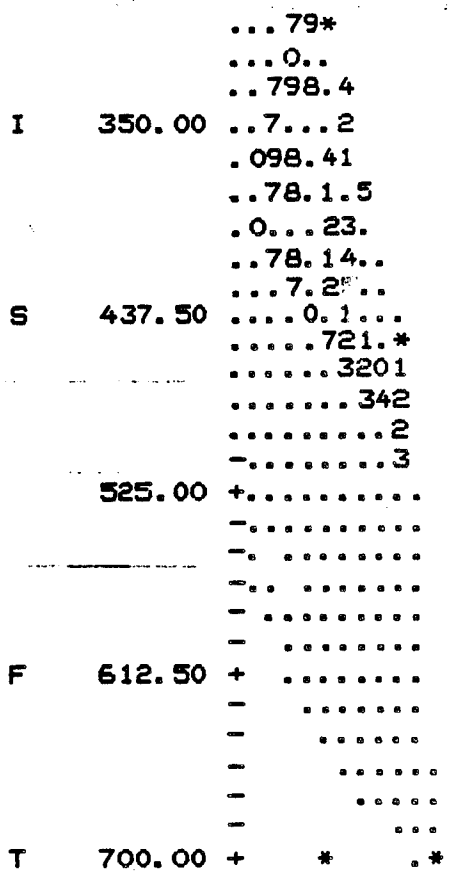
Failure Surface Specified By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	300.00	43.00
2	319.30	27.11
3	341.88	16.38
4	366.39	11.45
5	391.36	12.62
6	415.31	19.81
7	436.79	32.59
8	454.52	50.21
9	467.45	71.61
10	469.82	79.31

*** 2.460 ***

1




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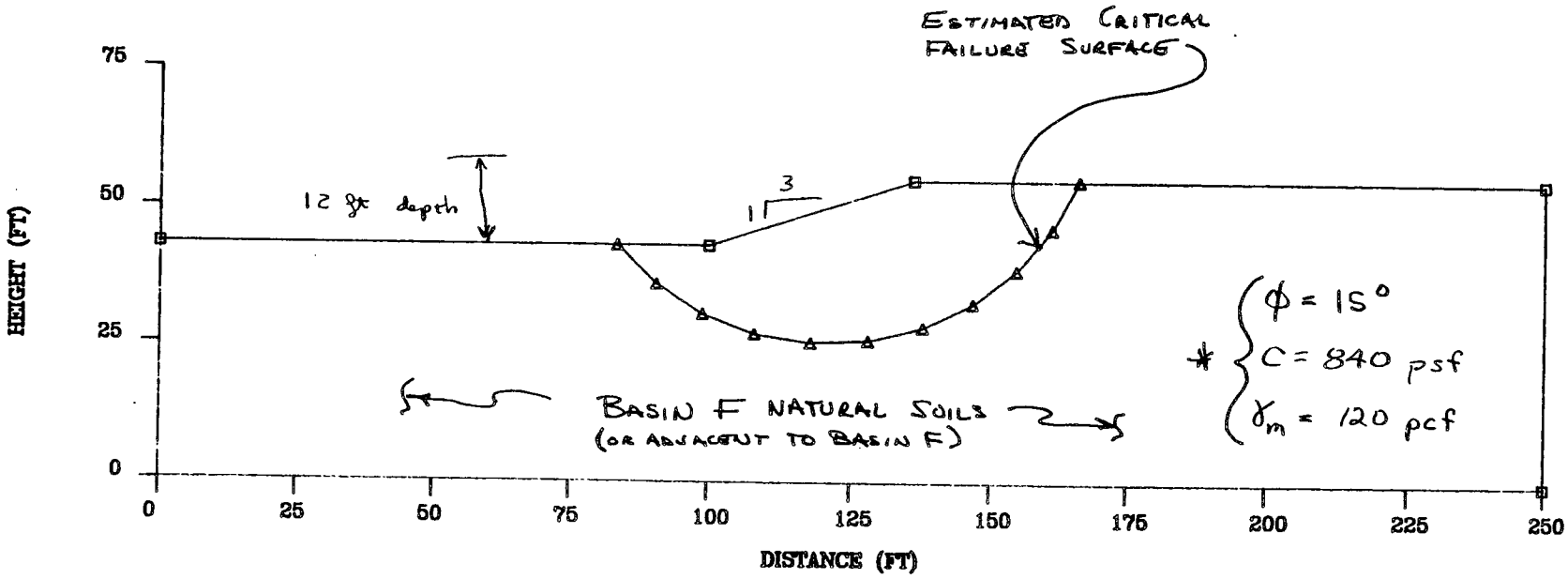
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EXCAVATION STABILITY

* ESTIMATED SOIL PROPERTIES FOR BASIN F NATURAL SOILS WERE TAKEN FROM "DIKE STABILITY ANALYSIS, BASIN F, RMA, JUNE 1978 (WES) SEE WASTE LANDFILL SLOPE STABILITY ANALYSIS FOR MORE INFORMATION.

ROCKY MOUNTAIN ARSENAL
LAGOON EXCAVATION
WOODWARD–CLYDE CONSULTANTS



□ GROUND SURFACE △ CRIT. CIRCLE FS 5.11

SLOPE STABILITY ANALYSIS FOR LAGOON EXCAVATION

** PCSTABL5 **

by
Purdue University

1

--Slope Stability Analysis--
Simplified Janbu, Simplified Bishop
or Spencer's Method of Slices

Run Date:	4-7-87
Time of Run:	11:45
Run By:	CB
Input Data Filename:	RMA-T3
Output Filename:	RMA-T3.OUT

PROBLEM DESCRIPTION ROCKY MOUNTAIN ARSENAL LAGOON EXCAVATION

BOUNDARY COORDINATES

3 Top Boundaries
3 Total Boundaries

Boundary No.	X-Left (ft)	Y-Left (ft)	X-Right (ft)	Y-Right (ft)	Soil Type Below Bnd
1	.00	43.00	100.00	43.00	1
2	100.00	43.00	136.00	55.00	1
3	136.00	55.00	250.00	55.00	1

1

ISOTROPIC SOIL PARAMETERS

1 Type(s) of Soil

Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez Surfac No.
1	120.0	120.0	840.0	15.0	.00	.0	1

1

A Critical Failure Surface Searching Method, Using A Random Technique For Generating Circular Surfaces, Has Been Specified.

100 Trial Surfaces Have Been Generated.

10 Surfaces Initiate From Each Of 10 Points Equally Spaced Along The Ground Surface Between X = 50.00 ft.
and X = 200.00 ft.

Each Surface Terminates Between X = .00 ft.
and X = 250.00 ft.

Unless Further Limitations Were Imposed, The Minimum Elevation At Which A Surface Extends Is Y = .00 ft.

10.00 ft. Line Segments Define Each Trial Failure Surface.

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	43.00
2	59.51	39.91
3	69.50	40.41
4	75.39	43.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 3 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	43.00
2	59.86	41.31
3	64.89	43.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 7 Coordinate Points

Point	X-Surf	Y-Surf

No.	(ft)	(ft)
1	50.00	43.00
2	57.07	35.93
3	66.17	31.77
4	76.14	31.04
5	85.74	33.84
6	93.76	39.82
7	95.82	43.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 6 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	43.00
2	58.65	37.98
3	68.40	35.75
4	78.37	36.54
5	87.65	40.26
6	91.02	43.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.67	43.00
2	73.78	35.97
3	83.77	35.55
4	91.46	41.95
5	91.60	43.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.00	55.00
2	157.76	48.69
3	167.76	48.48
4	175.78	54.45
5	175.93	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.00	55.00
2	157.24	48.11
3	167.07	46.24
4	176.34	49.99
5	179.87	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.00	55.00
2	159.75	52.77
3	169.60	51.07
4	179.53	49.90
5	189.51	49.25
6	199.51	49.14
7	209.50	49.56
8	219.46	50.51
9	229.35	51.99
10	239.15	53.99
11	243.02	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.00	55.00
2	157.65	48.56
3	167.65	48.25
4	175.68	54.20
5	175.90	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 3 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	150.00	55.00
2	159.70	52.56
3	169.03	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	166.67	55.00
2	174.84	49.24
3	184.74	47.77
4	194.24	50.89

5	198.37	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	166.67	55.00
2	176.09	51.67
3	186.07	52.37
4	191.10	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 3 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	166.67	55.00
2	176.61	53.93
3	178.93	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 10 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	166.67	55.00
2	176.36	52.53
3	186.20	50.74
4	196.13	49.62

5	206.12	49.19
6	216.12	49.44
7	226.08	50.37
8	235.95	51.99
9	245.68	54.28
10	248.03	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	166.67	55.00
2	175.08	49.60
3	184.47	46.15
4	194.38	44.81
5	204.35	45.64
6	213.90	48.60
7	222.58	53.56
8	224.16	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	166.67	55.00
2	174.67	49.00
3	183.52	44.35
4	193.00	41.17
5	202.87	39.53
6	212.87	39.48
7	222.75	41.03
8	232.26	44.12
9	241.15	48.69
10	249.21	54.61
11	249.59	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	55.00
2	191.91	49.86
3	201.91	50.16
4	209.00	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	55.00
2	190.43	47.96
3	200.34	46.62
4	209.05	51.53
5	210.56	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	55.00
2	192.54	51.08
3	202.24	48.68
4	212.21	47.84
5	222.18	48.59
6	231.90	50.92
7	241.14	54.76
8	241.52	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	55.00
2	192.56	51.15
3	202.32	48.95
4	212.31	48.47
5	222.23	49.72
6	231.78	52.66
7	236.36	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	183.33	55.00
2	191.63	49.42
3	201.54	48.07
4	211.03	51.21
5	214.89	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)

1	183.33	55.00
2	192.95	52.27
3	202.81	50.60
4	212.80	50.01
5	222.78	50.52
6	232.65	52.12
7	242.29	54.78
8	242.85	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	207.90	48.87
3	217.87	49.65
4	222.90	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	208.04	49.05
3	217.96	50.27
4	221.86	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	207.71	48.63
3	217.02	44.99
4	227.01	44.44
5	236.66	47.03
6	245.03	52.51
7	247.01	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	207.35	48.22
3	217.30	47.21
4	225.86	52.38
5	226.92	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 3 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	209.82	53.10
3	214.11	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 5 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	207.07	47.93
3	217.07	47.89
4	224.20	54.90
5	224.20	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	209.56	52.06
3	219.43	53.68
4	221.27	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	208.21	49.29
3	217.72	46.19
4	227.72	45.96
5	237.36	48.63
6	245.82	53.96
7	246.73	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 4 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	209.63	52.32
3	219.63	52.32
4	229.18	55.00

Factor Of Safety For The Preceding Specified Surface =*******

The Factor Of Safety For The Trial Failure Surface Defined By The Coordinates Listed Below Is Misleading.

Failure Surface Defined By 7 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	200.00	55.00
2	208.15	49.20
3	217.63	46.03
4	227.63	45.78
5	237.26	48.46
6	245.69	53.84
7	246.68	55.00

Factor Of Safety For The Preceding Specified Surface =*******

1

Following Are Displayed The Ten Most Critical Of The Trial Failure Surfaces Examined. They Are Ordered - Most Critical First.

* * Safety Factors Are Calculated By The Modified Janbu Method * *

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	83.33	43.00
2	90.49	36.01
3	98.91	30.62
4	108.25	27.04
5	118.12	25.43

6	128.11	25.85
7	137.81	28.28
8	146.81	32.63
9	154.75	38.70
10	161.30	46.27
11	166.18	54.99
12	166.18	55.00

*** 5.109 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	83.33	43.00
2	90.82	36.37
3	99.40	31.24
4	108.78	27.77
5	118.64	26.08
6	128.64	26.23
7	138.44	28.21
8	147.71	31.96
9	156.13	37.35
10	163.42	44.20
11	169.32	52.27
12	170.63	55.00

*** 5.253 ***

1

Failure Surface Specified By 13 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.67	43.00
2	73.95	36.15
3	82.30	30.65
4	91.47	26.65
5	101.18	24.28
6	111.16	23.61
7	121.11	24.66
8	130.73	27.39
9	139.74	31.72
10	147.87	37.53
11	154.90	44.65
12	160.60	52.87
13	161.59	55.00

*** 5.263 ***

Failure Surface Specified By 12 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.67	43.00
2	74.77	37.15
3	83.68	32.60
4	93.18	29.48
5	103.05	27.85
6	113.05	27.76
7	122.95	29.20
8	132.50	32.14
9	141.50	36.51
10	149.71	42.21
11	156.96	49.10
12	161.50	55.00

*** 5.419 ***

1

Failure Surface Specified By 11 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.67	43.00
2	73.77	35.96
3	82.24	30.64
4	91.65	27.27
5	101.57	26.03
6	111.53	26.96
7	121.05	30.04
8	129.67	35.10
9	136.99	41.92
10	142.65	50.16
11	144.61	55.00

*** 5.614 ***

Failure Surface Specified By 9 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	100.00	43.00
2	108.59	37.87
3	118.10	34.81
4	128.07	33.95
5	137.97	35.35
6	147.30	38.93
7	155.60	44.52
8	162.43	51.83
9	164.27	55.00

*** 5.678 ***

1

Failure Surface Specified By 8 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	83.33	43.00
2	91.95	37.93
3	101.60	35.30
4	111.60	35.30
5	121.25	37.94
6	129.86	43.02
7	136.83	50.19
8	139.49	55.00

*** 5.693 ***

Failure Surface Specified By 14 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.67	43.00
2	74.95	37.39
3	83.85	32.84
4	93.24	29.41
5	102.99	27.16
6	112.93	26.11
7	122.93	26.29
8	132.83	27.69
9	142.49	30.30
10	151.75	34.06
11	160.48	38.93
12	168.55	44.84
13	175.84	51.69
14	178.60	55.00

*** 5.714 ***

1

Failure Surface Specified By 15 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	50.00	43.00
2	57.77	36.70
3	66.23	31.38
4	75.28	27.12
5	84.78	23.98
6	94.58	22.01
7	104.55	21.23
8	114.54	21.66
9	124.41	23.30
10	134.00	26.10
11	143.19	30.05
12	151.84	35.07

13	159.82	41.10
14	167.01	48.05
15	172.66	55.00

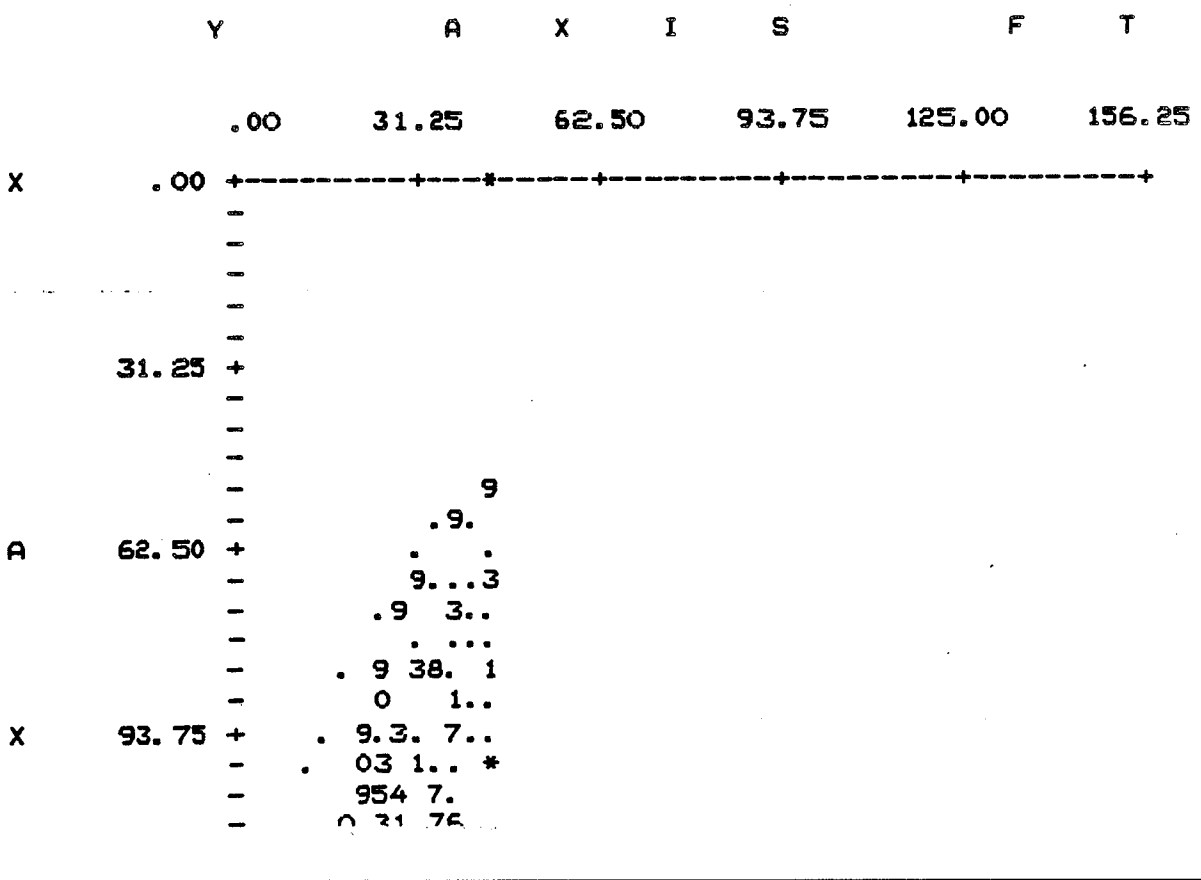
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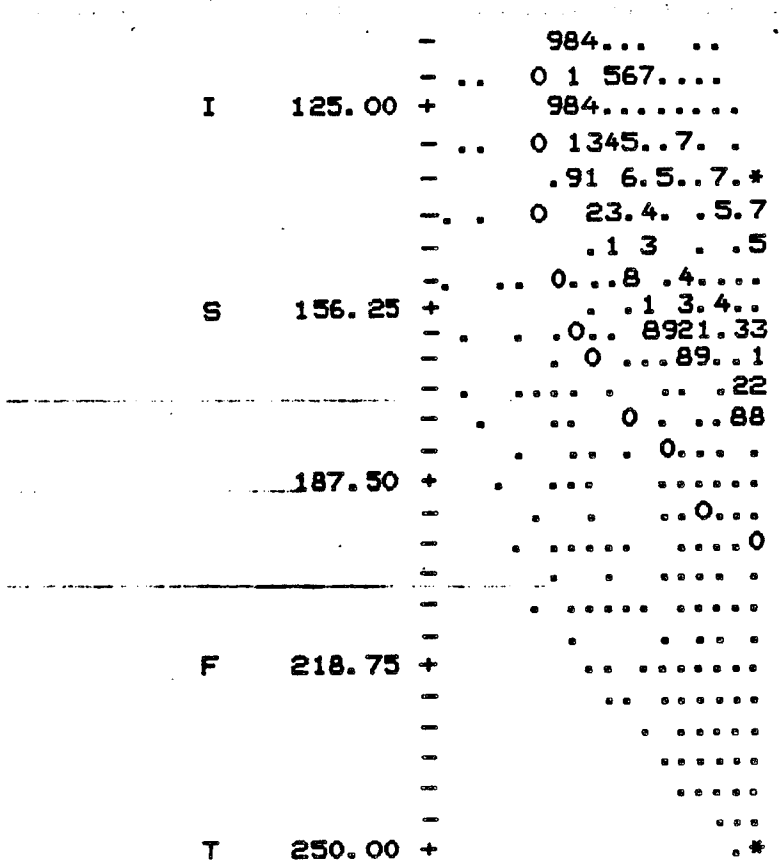
Failure Surface Specified By 16 Coordinate Points

Point No.	X-Surf (ft)	Y-Surf (ft)
1	66.67	43.00
2	74.03	36.23
3	82.15	30.39
4	90.91	25.57
5	100.18	21.82
6	109.83	19.21
7	119.73	17.77
8	129.72	17.52
9	139.68	18.47
10	149.45	20.61
11	158.89	23.89
12	167.88	28.28
13	176.28	33.71
14	183.96	40.10
15	190.83	47.37
16	196.48	55.00

*** 5.978 ***

1




I
125.00
S
156.25
187.50
F
218.75
T
250.00

DATE

JOB NO.

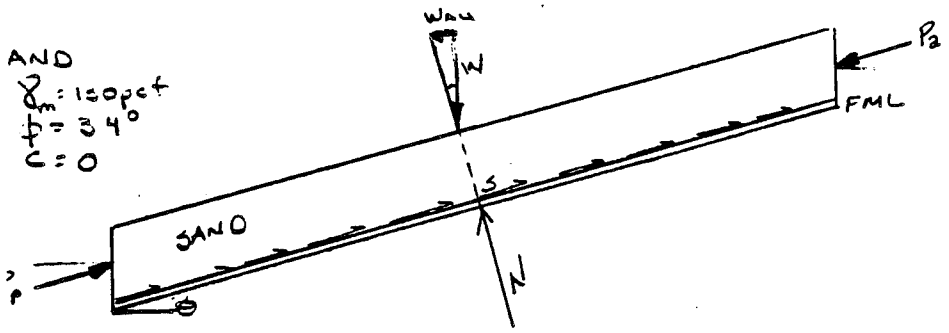
PAGE NO.

STABILITY ANALYSES

SAND COVER OVER FML

INFINITE SLOPE

FORCES ON WEDGE



AND
γ_m = 130 pcf
ϕ = 34°
C = 0

ACTIVE FORCES:

$W_{A_1} = \frac{1}{2}(2)(1)(130) = 130$ lb

$P_{A_1} = W_{A_1}(\tan 45 - \phi/2) - 2c\cos(45 + \phi/2)$

$= 130(\tan(45 - \frac{34}{2}))$

$= 69.1$ lb.

PASSIVE FORCE

$W_{P_1} = \frac{1}{2}(2)(3.5)(130) = 455$ lb

$P_{P_1} = W_{P_1}\tan(45 + \phi/2)$

$P_{P_1} = 455\tan(45 + \phi/2)$

$P_{P_1} = 855.7$ lb

$W\sin\theta = 2(L)(130) = 260L$

$S_{req} = P_A\cos(\beta_A - \theta) - P_P\cos(\beta_P - \theta) + W\sin\theta$

$= 69.1 - 855.7 + 260L\sin 15° = 67.3L - 786.6$

(Table) $S_{max} = c \cdot L + [W\cos\theta + P_A\sin(\beta_A - \theta) - P_P\sin(\beta_P - \theta)]\tan\phi$

$= [260L\cos 15° + 130\sin 5° - 455\sin(15 - 15)]\tan\phi$

$= 251L\tan\phi$

$FS = \frac{S_{max}}{S_{req}}$

Assume FS = 1.5

$1.5 = \frac{251L\tan\phi}{67.3L - 786.6}$

L = 1000'	ϕ = 21.6
L = 500'	ϕ = 21.4
L = 250'	ϕ = 20.9
L = 140'	$\phi \approx 20°$
L = 100'	ϕ = 19.5
L = 50'	ϕ = 17.1

Reasoning/Conclusion

If the soil-geotextile interface is assumed to be $\delta = 27°$ with an effectiveness of 90% then $\delta_{eff} = 27° \times .9 = 24.3°$. (These are typical values and were assumed.) Choosing a slope length of about 140 feet from the waste pile geometry we can see that $\phi \simeq 20°$ is required to achieve a safety factor of 1.5. Since $\delta_{eff} = 24.3°$ is greater than $\phi = 20°$ there is an estimated factor of safety greater than 1.5 against sliding of the slope under normal conditions. Benching the slope will increase the F.S.

Note: the slope should be constructed above the geotextile from bottom up to allow passive resistance at the base of the slope.

NORTHWEST GEOTECH CONSULTANTS
4/6/87
CONCORD, CA
CHECKED BY: RSJ
4/23/87

Subject TOTAL SETTLEMENT OF TOP OF WASTE PILE Project No. 86C8554P

By D. HAWK Checked By RSJ Task No. 2

File No. 21947

Date 4/23/87 Date 4/23/87 Sheet 1 of 2

PROBLEM: ESTIMATE MAXIMUM SETTLEMENT AT TOP OF WASTE PILE AND EXAMINE POSSIBLE EFFECTS

REASONING/SOLUTION:

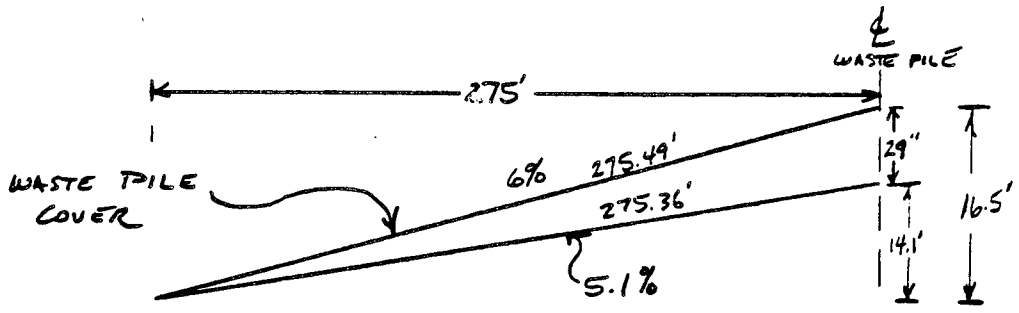
FROM SEPARATE ANALYSES IT WAS FOUND THAT THE MAXIMUM SETTLEMENT EXPECTED AT THE BASE OF THE WASTE PILE WAS 13" AND WITHIN THE WASTE PILE WAS 16"

THEREFORE, TOTAL SETTLEMENT AT THE WASTE PILE TOP, AT A MAXIMUM, IS EXPECTED TO BE

$$13'' + 16'' = 29''$$

LESS THAN 29 INCHES OF SETTLEMENT SHOULD OCCUR DUE TO SOLIDIFICATION OF WASTE & BECAUSE MUCH OF THE SETTLEMENT WILL OCCUR DURING CONSTRUCTION.

ASSUMING THE MAXIMUM SETTLEMENT OF 29" AT THE WASTE PILE TOP AND NO SETTLEMENT AT THE WASTE PILE EDGE THE CHANGE IN COVER SLOPES WOULD BE:



Subject TOTAL SETTLEMENT OF WASTE PILE TOP Project No. 86C8554P

By D. Hawk Checked By RSJ Task No. 2

File No. 21947

Date 4/23/87 Date 4/23/87 Sheet 2 of 2

CONCLUSIONS:

1) IF MAXIMUM EXPECTED SETTLEMENT OCCURS NO RELATED DAMAGE TO THE WASTE PILE COVER SYSTEM SHOULD OCCUR.

2) WITH MAXIMUM SETTLEMENT OF 29 INCHES THE WASTE PILE COVER SHOULD MAINTAIN A MINIMUM SLOPE OF 5% WHICH IS ADEQUATE FOR PROPER DRAINAGE.

3) WITH MAXIMUM SETTLEMENT OF 29 INCHES THE WASTE PILE COVER WOULD REDUCE IN LENGTH BY .13 FT (275.49'-275.36'). THIS REPRESENTS A COMPRESSIVE STRAIN OF .13/275 OR .05% WHICH IS WITHIN TOLERANCES FOR ALL MATERIALS USED IN THE WASTE PILE COVER SYSTEM.

Subject SETTLEMENT OF WASTE

Project No. 86C9554P

By D. HAWK

Checked By RSJ

Task No. 2

File No. 21947

Date 4/22/87

Date 4/23/87

Sheet 1 of 1

PROBLEM: ESTIMATE WASTE PILE SETTLEMENT ABOVE WASTE PILE BASE.

REASONING/SOLUTION:

NO INFORMATION IS AVAILABLE ON THE CONSOLIDATION CHARACTERISTICS OF THE SOLIDIFIED WASTE. THE WASTE WILL BE DEPOSITED OVER A PERIOD OF SEVERAL MONTHS AND WILL CONSIST OF PRIMARILY SILTY SANDS WITH SOME CLAYS. ADDITIONALLY, FLYASH OR ANOTHER ABSORPTION AGENT WILL BE INCORPORATED WHICH HAS A TENDENCY TO 'SOLIDIFY'.

DUE TO THE TIME OF CONSTRUCTION, A LARGE PORTION OF THE SETTLEMENT WITHIN THE WASTE PILE IS EXPECTED TO OCCUR PRIOR TO FINAL CAPPING. BASED ON EXPERIENCE WITH SILTY SANDS AND NEGLECTING EFFECTS OF THE SOLIDIFYING AGENT THE MAXIMUM SETTLEMENT WILL PROBABLY BE LESS THAN 2 PERCENT OF TOTAL HEIGHT OF WASTE.

FROM THE ATTACHED WASTE PILE MAXIMUM SECTION, THE HEIGHT OF PILE FROM TOP TO BASE IS
5244 - 5180 = 64 FEET

MAXIMUM SETTLEMENT = .02 × 64 = 1.3 FT

= 1.3 × 12 = 16 INCHES

⇒ THEREFORE LESS THAN 16 INCHES OF SETTLEMENT IS EXPECTED WITHIN THE WASTE PILE; MUCH LESS COULD OCCUR DUE TO SOLIDIFICATION WITH FLYASH.

Subject SETTLEMENT OF WASTE PILE BASE @ ℄ Project No. 86C9554P

By D. HAWK Checked By RSJ Task No. 2

File No. 21947

Date 4/22/87 Date 4/23/87 Sheet 1 of 13

PROBLEM: CALCULATE SETTLEMENT BENEATH THE BASE OF THE WASTE PILE DUE TO SURCHARGE LOADING FROM THE WASTE PILE

REASONING / SOLUTION

THE ALLUVIUM WILL RECEIVE A RELATIVELY UNIFORM SURCHARGE OVER A LARGE AREA. ALTHOUGH SOME PRE-CONSOLIDATION OF THE ALLUVIUM HAS PROBABLY OCCURRED THE ALLUVIUM IS GENERALLY DESCRIBED IN GEOLOGICAL REPORTS AS BEING NORMALLY CONSOLIDATED.

CONSOLIDATION DATA FROM ALLUVIAL MATERIAL ACCUMULATED ON PAST PROJECTS AT RMA WAS USED. FIELD CURVES WERE PREPARED USING THIS DATA AS SHOWN ON FIGURES 1 AND 2, AND SETTLEMENTS WERE CALCULATED. TO THIS WAS ADDED COMPRESSION OF THE DENVER FORMATION BEDROCK DUE TO THE UNIFORM SURCHARGE LOADING. DATA USED FOR THE BEDROCK WAS TAKEN FROM CONSOLIDATION TESTING OF TYPICAL DENVER FORMATION MATERIAL.

Subject FIELD CURVES FOR CONSOLIDATION TESTS Project No. 86C9554P

By D HOWK Checked By RSJ Task No. 2

File No. 21947

Date 4/21/87 Date 4/23/87 Sheet 2 of 13

TO COMPUTE THE FIELD CURVE FOR CONSOLIDATION TESTS (STRAIN VS. LOG P) WE NEED TO FIND

$$\varepsilon = \frac{0.6\,(H_o - H_s)}{H_o}$$

WHERE: ε = STRAIN REFERENCE POINT AT THE BASE OF THE FIELD CURVE

H_o = INITIAL HEIGHT OF THE CONSOLIDATION SAMPLE

H_s = INITIAL HEIGHT OF SOLIDS GIVEN BY:

$$H_s = \frac{W_s}{G\,A\,\gamma_w}$$

Where:

W_s = Weight of Solids
G = Specific Gravity
A = Area of Sample
γ_w = unit weight of water

FROM THE TYPICAL CONSOLIDATION TEST

$H_o = .75$ inches

$$A = \frac{\pi\,(1.935)^2}{4}\ in^2 = 2.94\ in^2$$

AND IT IS KNOWN THAT

$\gamma_w \cong 62.4$ pcf
$G \cong 2.7$

FROM DATA FOR CLAY (See figure 1 attached)

$\gamma_{Dry} = 109.9$ pcf

Subject FIELD CURVE FOR CONSOLIDATION TESTS | Project No. 86C855Y P

By D. HAWK | Checked By RSJ | Task No. 2

Date 4/21/87 | Date 4/23/87 | File No. 21947

Sheet 3 of 13

Calculate the weight of solids for H_s = .75 inches
$G = 2.7$ & $A = 2.94\ in^2$

$$Volume = .75(2.94) = 2.205\ in^3$$

$$2.205\ in^3 \times \frac{FT^3}{12^3\ in^3} = .001276\ FT^3$$

$$W_s = 109.9\ \frac{lb}{FT^3} \times .001276\ FT^3 = .1402\ lbs.$$

Calculate H_s

$$H_s = \frac{.1402(12^2)}{2.7(2.94)62.4} = .0408\ FT = .49\ inches$$

Calculate ε

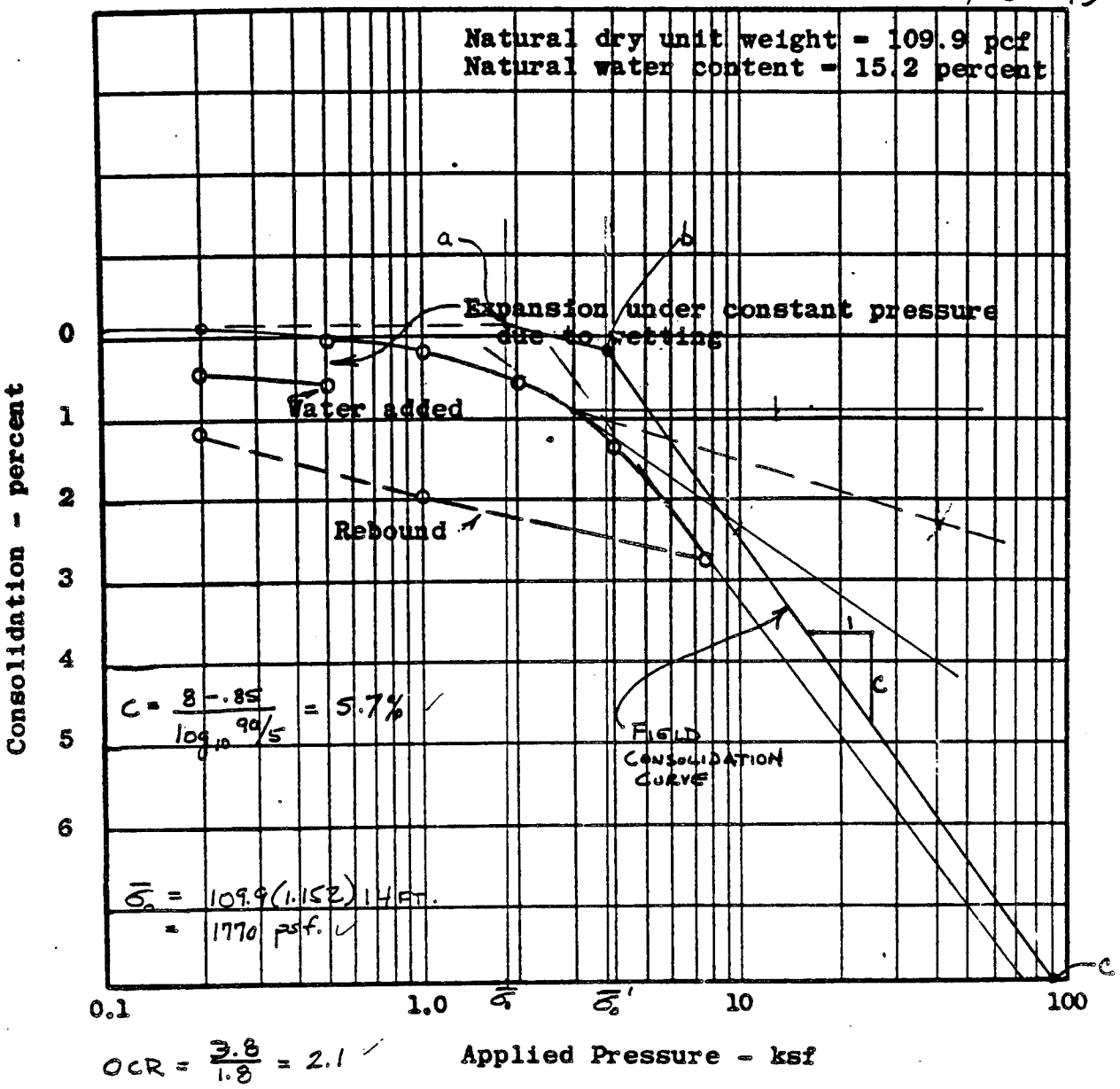
$$\varepsilon = \frac{0.6(.75-.49)}{.75} = .21$$

NOTE: The point shown @ 8 percent consolidation was determined geometrically in line with a point for 21 percent consolidation for figure 1.

Calculate C (slope of Consolidation vs. Pressure Curve)

$$C = \frac{8-.85}{\log_{10} 90/5} = \frac{7.15}{1.255} = 5.7\%$$

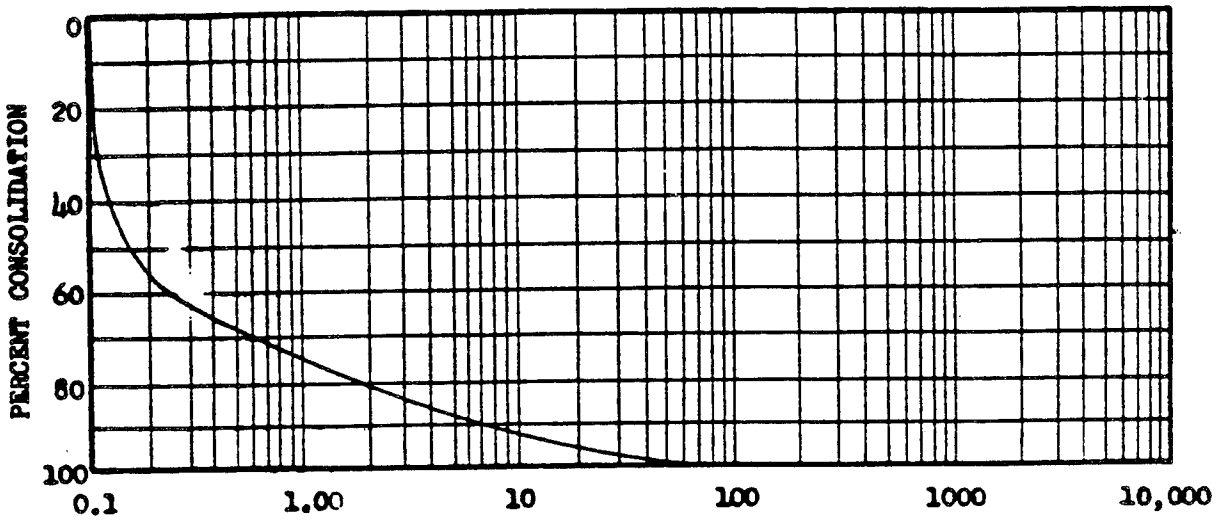
Use C = .057



$C = \frac{8 - .85}{\log_{10} 90/5} = 5.7\%$ ✓

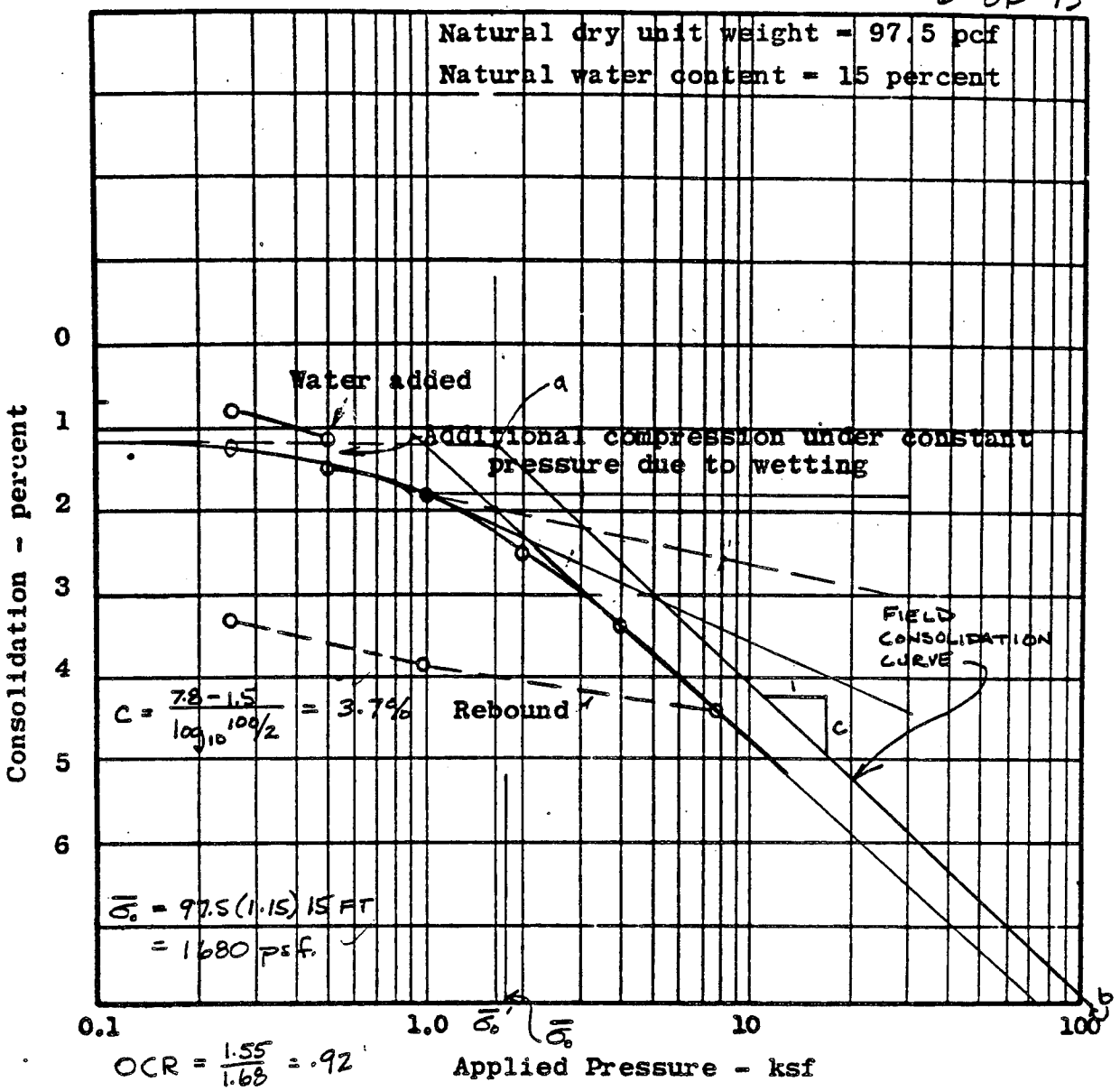
$\bar{\sigma}_o = 109.9(1.152)\,14\text{ FT.}$
$= 1770$ psf. ✓

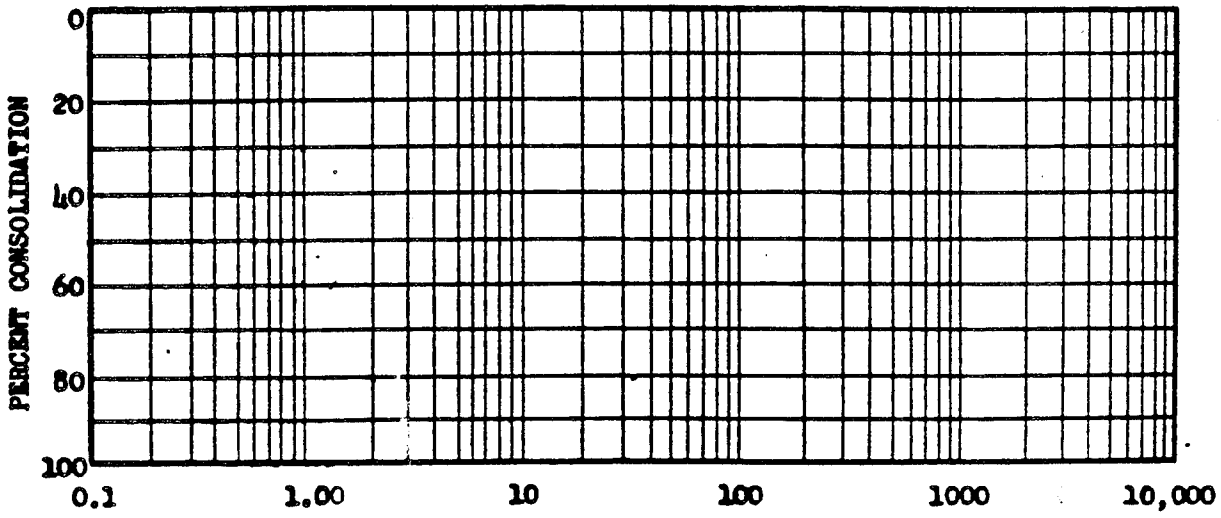
$OCR = \frac{3.8}{1.8} = 2.1$ ✓



CONSOLIDATION TEST RESULTS
Typical sample of clay from Boring 2 @ 14'-0"
* From past WCC work at RMA.

Fig. 1





CONSOLIDATION TEST RESULTS
Typical sample of clayey sand from Boring 10 @ 15'-0"
* From past WCC work at RMA

Fig. 2

Subject SETTLEMENT OF WASTE PILE BASE @ E | Project No. 86C855YP

By D. HAWK | Checked By RSJ | Task No. 2

Date 4/22/87 | Date 4/23/87 | File No. 21947

Sheet 7 of 13

WEIGHT OF MATERIALS

MATERIAL TYPE	γ_D (PCF)	M_c (%)	γ_m (pcf)	USE (pcf)
TOPSOIL	75	25	93.8	95
COHESIVE COVER	113.3	14.6	129.8	130
SOIL COVER	116.4	13.1	131.6	130
WASTE	105	15	120.8	120

TOTAL WEIGHT OF PILE @ MAXIMUM SECTION

DEPTH (FT)	DISTANCE (FT)	UNIT WEIGHT (PCF)	TOTAL WEIGHT (PSF)
0-0.5	0.5	95	47.5
0.5-1.5	1.0	130	130
1.5-3.5	2.0	130	260
3.5-52.0*	48.5	120	5820

* 52 FT EQUALS DEPTH FROM TOP OF WASTE PILE TO ORIGINAL GROUND.

TOTAL = 6257.5 psf ✓

USE 6250 psf

ASSUME THE WEIGHT OF MATERIAL BELOW THE ORIGINAL GROUND SURFACE WHICH WAS REMOVED EQUALS THE WEIGHT OF THE WASTE PILE PORTION WHICH REPLACES IT. THE NET CHANGE IN PRESSURE AT THE BASE OF THE WASTE PILE IS THEREFORE 6250 psf. ✓

Subject SETTLEMENT OF WASTE PILE BASE @ ℄ Project No. 86C8554P

By D. HAWK Checked By RSJ Task No. 2

File No. 21947

Date 4/22/87 Date 4/23/87 Sheet 8 of 13

WASTE PILE MAXIMUM SECTION

(Taken @ ℄ OF WASTE PILE TRANSVERSE CROSS SECTION - SHEET 14 OF RMA 95% DRAWINGS.)

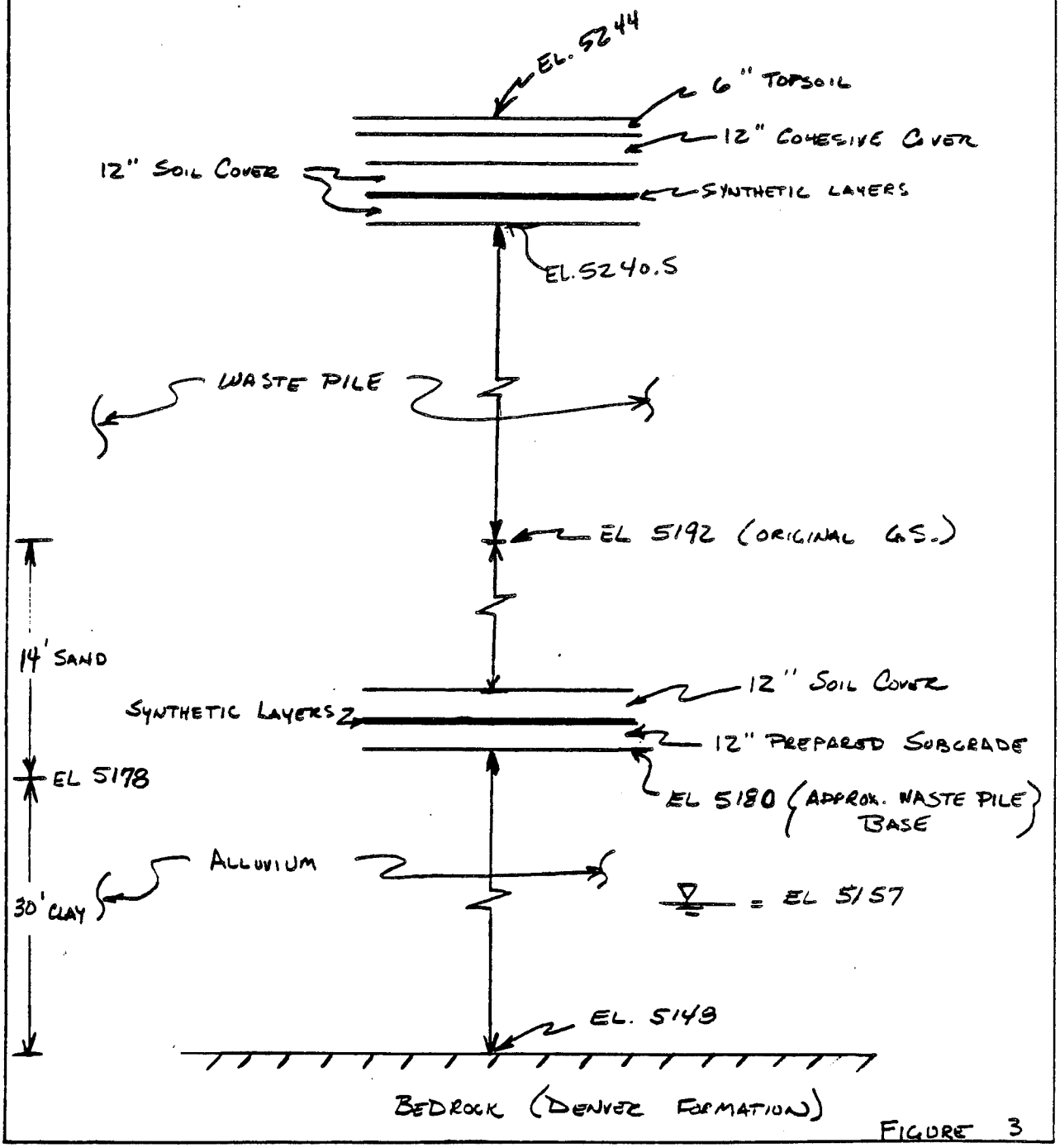


FIGURE 3

Subject SETTLEMENT OF WASTE PILE BASE @ ℄ Project No. 86C8554P

By D. HAWK Checked By RSJ Task No. 2

File No. 21947

Date 4/22/87 Date 4/23/87 Sheet 9 of 13

COMPUTE SETTLEMENT OF ALLUVIUM

MATERIAL TYPE	DEPTH INTERVAL (FT)	AVG. DEPTH (FT)	P_o (PSF)	ΔP (PSF)	P_1 (PSF)	C	H (FT)	S** (FT)
1) SAND (No. G.W.)	12-14	13	1599	6250	7849	.037	2	.05
2) CLAY * (No. G.W.)	14-35	24.5	3056	6250	9306	.057	21	.58
3) CLAY (w/ G.W.)	35-44	39.5	4679	6250	10,929	.057	9	.19
						TOTAL =		.82 (FT)

* Note - assume all consolidation is on the virgin curve.

** $S = C(H) \log_{10} P_1/P_o$

Sand unit weight = 122.7 pcf Use 123 pcf

Clay unit weight = 126.6 pcf Use 127 pcf

Clay unit weight (Submerged) = 127 - 62.5 = 64.5 pcf

Subject SETTLEMENT OF WASTE PILE BASE @ ℄ Project No. 86C85C4P

By D. HAWK Checked By RSJ Task No. 2

File No. 21947

Date 2/11/87 Date 4/23/87 Sheet 10 of 13

COMPUTE COMPRESSION OF BEDROCK BENEATH WASTE PILE

ASSUME BEDROCK IS BELOW FREE WATER LEVEL SUCH THAT

$\gamma_{SAT} = 140$pcf $\gamma_w = 62.5$ $\gamma'_B = 77.5$pcf

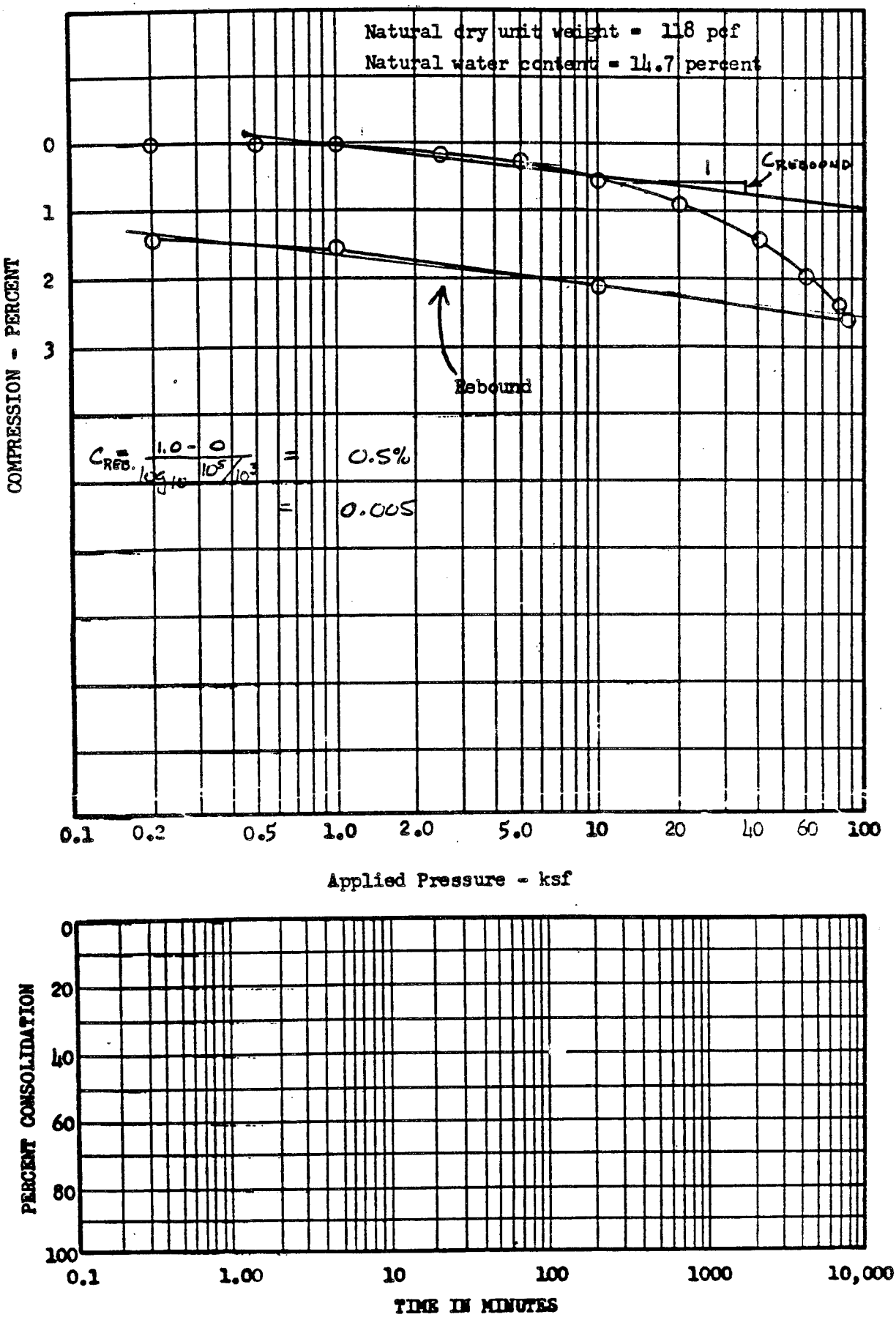
DEPTH INTERVAL	AVERAGE DEPTH	P_o (psf) ②	ΔP (psf)	P_1 (psf)	PERCENT COMPRESSION ①	H (FT)	S (FT) ③
44-200	122	11,015	6150	17,165	.096	156	.15
200-400	300	24,810	5250	30,060	.042	200	.08
400-600	500	40,310	3550	43,860	.018	200	.04
600-800	700	55,810	2550	58,360	.010	200	.02
							.29 FT.

① PERCENT COMPRESSION = $.5 \log_{10}(P_1/P_o)$ See attached figure for typical Denver Shale

② $4970 + 77.5(\text{DEPTH} - 44)$

③ $S = \frac{\text{Percent Compression}}{100} \times H$

ASSUMPTION: BEDROCK WAS OVERCONSOLIDATED AT SOME POINT IN TIME TO A PRESSURE AT LEAST 6250 psf GREATER THAN AT PRESENT. THIS OVERCONSOLIDATION WOULD EXTEND TO GREAT DEPTH UNIFORMLY SO THAT ALL MATERIAL WOULD CONSOLIDATE USING REBOUND PORTION OF CURVE. SINCE ΔP DECREASES WITH DEPTH THIS SHOULD BE REALISTIC.



CONSOLIDATION TEST RESULTS

Typical blue shale specimen from Hole 2 at depth 10'-0" below surface of bedrock.

* From typical Denver Formation tests.

Fig. 4

Subject SETTLEMENT OF WASTE PILE (TOTAL)

By D. HAWK Checked By RCJ

Date 2/11/87 Date 4/23/87

Project No. 5623-54 P

Task No. 2

File No. 2.2.7

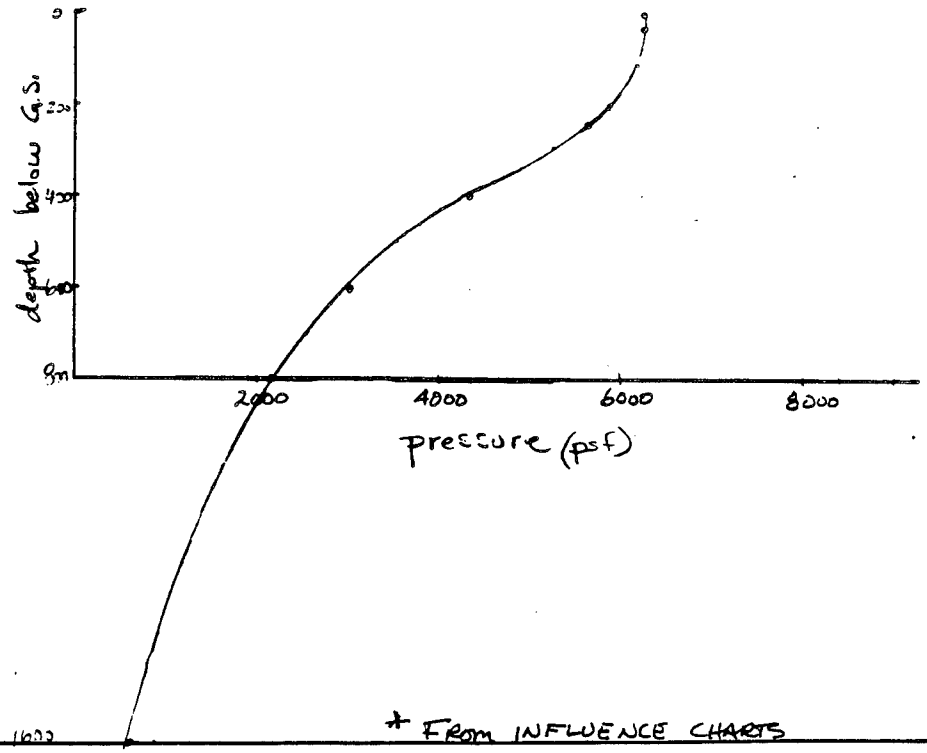
Sheet 12 of 13

PRESSURE WITH DEPTH IN DENVER FORMATION CAUSED BY WASTE PILE @ ℄ *

Q = 6250 psf

AREA = 800 × 800 = 640,000 FT² ~ 15 ACRES

DEPTH	INFLUENCE FACTOR	ΔP PRESSURE (psf)
32'	1	6250
200'	.94	5875
243'	.90	5625
400'	.69	4312
600'	.48	3000
800'	.34	2125
1600'	.10	625



* FROM INFLUENCE CHARTS

Subject SETTLEMENT OF WASTE PILE BASE @ E

By D. HAWK Checked By RSJ

Date 4/22/87 Date 4/23/87

Project No. 86C8554P

Task No. 2

File No. 21947

Sheet 13 of 13

COMPUTE TOTAL SETTLEMENT AT BASE OF WASTE PILE

(1) SETTLEMENT OF ALLUVIUM = .82 FT

(2) COMPRESSION OF BEDROCK = .29 FT

(3) TOTAL SETTLEMENT @ WASTE PILE BASE = 1.11 FT

(4) CONVERT TO INCHES

$$1.11 \text{ FT} \times \frac{12 \text{ IN}}{\text{FT}} = 13.3 \text{ IN.}$$

SAY 13 IN.

Subject _____ Project No. _____

By Checked By Task No. _____

File No. _____

Date Date Sheet _____ of _____

ATTACHMENTS

Subject SETTLEMENT OF WASTE PILE

Project No. 86C8554P

By D. HAWK Checked By RSJ

Task No. 2

File No. 21947

Date 4/22/87 Date 4/23/87

Sheet 1 of 3

GEOTECHNICAL INFORMATION

1) The Alluvium[1] has been approximated at 32 to 45 feet thick in the waste pile area. It consists of silty sands, clayey silts, clayey sands and silty to clayey gravels.

2) The Denver Formation[1] is approximated as 400 to 600 feet thick underlying the Arsenal. It generally consists of clay shale, Clay, Sand, Siltstone and Sandstone.

3) Groundwater is generally located at about 30 to 40 feet below the existing ground surface. USE 35' BELOW G.S.

4) Some soil characteristics for borrow material previously used at the Arsenal are provided below.

a) Sandy Clay & Clayey Silt[2]

M_c (NAT) = 9%
% PASS #200 = 60%
LL = 29
PI = 10
$\gamma_{D(MAX)AVG.}$ = 113.3 pcf
$M_{c(OPT)AVG}$ = 14.6%
K @ 95% max. density = 5.2×10^{-8} cm/sec

b) Clayey fine Sand[2]

M_c (NAT) = 7%
% PASS #200 = 34%
$\gamma_{D(MAX)AVG}$ = 116.4 pcf
$M_{c(OPT)AVG}$ = 13.1%
K @ 94% max density = 1.4×10^{-4} cm/sec

Subject SETTLEMENT OF WASTE PILE

By D. HAWK Checked By RSJ

Date 4/22/87 Date 4/23/87

Project No. 86C8554P

Task No. 2

File No. 21947

Sheet 2 of 3

REFERENCES:

1) CLOSURE PLAN, BASIN F, RMA, DEC. 1985 EBASCO.

2) FINAL DESIGN ANALYSIS, BASIN F LIQUID WASTE DISPOSAL FACILITY, RMA, AUGUST 1981, BLACK AND VEATCH

(3) ASTM D 698-78

Subject SETTLEMENT OF WASTE PILE (TOTAL) Project No. 86C3554P

By D. HAWK Checked By RSJ Task No. 2

File No. 21947

Date 2/4/87 Date 4/23/87 Sheet 3 of 3

1) FROM EXCAVATION PLAN BY HDR:

THE BASE OF THE LANDFILL WILL BE ABOUT ELEVATION 5180 AT MAXIMUM SECTION

2) FROM "AN ANALYSIS OF THE SUBSURFACE INVESTIGATIONS CONDUCTED AROUND BASIN F" MARCH 1978

THE TOP OF BEDROCK "MUDSTONE" IS ABOUT EL 5143 IN THE VICINITY OF THE LANDFILL

3) DEPTH OF ALLUVIUM = 5180 - 5148 = 32 FT.
Below base of waste pile (includes subgrade preparation area as part of waste pile)

4) FROM DIKE STABILITY ANALYSIS - BORINGS 482 - 485
BASIN F, RMA JUNE 1978
BY MITCHELL & JENG

	ALLUVIUM			
BORING NO.	CL	SM	SC	TOTAL
482	72	20	—	92
483	56	18	20	94
484	96	—	—	96
485	56	58	—	114
TOTALS	280	96	20	396
%	71%	24%	5%	

SM: CLAY = 70%

SAND = 30%

+ FOR MATERIAL PROPORTION IN ALLUVIUM
USE .70 x 44 = 30 FT CLAY
BELOW .30 x 44 = 14 FT SAND

CIVIL DESIGN

Ckd By: BKL
A/87

BASIN F

CIVIL DESIGN

1. WASTE PILE

The Waste Pile design included several features which were controlled by client requirements, and several features which were derived through independent calculation. Waste Pile cross-sections for the layering of liner, leachate collection and cap design were arrived at during meetings with the client. Leachate collection system design, including sumps, subcell configuration and outside slope stability were calculated independently.

Several slope stability analyses for the Rocky Mountain Arsenal were completed with the IBM PC AT using a computer program called "STABLE." The analyses considered slope stability for the proposed waste landfill and the surface impoundment excavation.

The computer program used the Modified Janbu Method to estimate the factor of safety. The results from the program are for the ten most critical circles. The input data for each analyses is included with the output results.

Manual calculations were done for the soil cover over a synthetic fabric. The soil layer was two feet thick and analyzed as an infinite slope to estimate the coefficient of friction required between the cover soil and synthetic layers.

Three subcells were selected based upon two primary factors. The first factor involved the ability to cap subcells quickly. This is a normal driving factor causing selection of many small subcells; however, with an above ground waste pile and a total elevation gain of approximately 35 feet, three subcells close out essentially as quickly as four or more subcells. The second factor involved leachate collection. A single layer of geonet is capable of transmitting the average annual precipitation in a 700' x 250' subcell with the exception of the vicinity of the sump. Larger subcells would exceed the capacity of one layer of geonet.

Leachate collection system calculations were based upon transmitting the average annual precipitation. The soil cover was specified as material to provide a slight retardation of water infiltration. This will even out peaks in the transmission of storm events. Sump size calculations were also based upon average annual precipitation.

The geometry of the Waste Pile was established using the following givens and/or assumptions:

1.1	Volume of Excavation	= 405,000 C.Y.
1.2	10% Vol. Increase of Excav. Mtl. Due to Absorbtive Mtl.	= 40,000 C.Y.
1.3	Vol. of Enhanced Evap. Piping, Sewer Pipe and Misc. Debris	= 15,000 C.Y.

1.4	Rip-Rap	= 25,000 C.Y.
1.5	Total Waste Pile Vol.	= 485,000 C.Y.
1.6	25% Add'l. Vol.	= 120,000 C.Y.
1.7	Waste Pile Design Vol.	= 605,000 C.Y.
1.8	Sideslopes of 4:1 (to be verified by WCC)	
1.9	Height at Top Slope = 35 ft. max.*	
1.10	5 ft. high Berm w/15' wide top and 4:1 side slopes	
1.11	Balanced interior grading to sumps*	
1.12	6% min. slope at top	
1.13	10' berm at mid-height	
1.14	1 ft. clay liner, bottom and top*	
1.15	Single HDPE Liner-Geonet-Geotextile @ bottom*	
1.16	3 sumps or subcells (250' x 700')	
1.17	Prepared Foundation (balanced earthwork)*	
1.18	1 ft. soil layer above liners (mtl. may be contaminated inside berm toes)*	
1.19	Runoff/Gas Collection System at top to have Geotextile-Geonet-HDPE Liner - Geonet-Geotextile liners*	
1.20	Top to be 6" Top Soil - 1 ft. Clay - 1 ft. Uncontaminated Soil-Runoff/Gas Collection System - 1 ft. Uncontaminated Soil*	
1.21	Top Vents at 100 ft. ctrs. B.W.	
1.22	2% min. slope of subcells	
1.23	Sludge Overburden, Liner and 6" typ. soil under liner to be removed under waste pile*	
1.24	Runoff Collection System to intercept Geonet at Berm	

* - parameter provided by COE

Ckd By: BKL
4/87

2. EXCAVATION

The limits of excavation and depths were established with the following parameters:

2.1 Depth of overburden obtained from COE approximately 18 in. contaminated material, bituminous liner and 6 in. material below liner.

2.2 Limits of 6 ft. excavation derived from the following parameters:*

- 2.2.1 At borings 4620, 4626 & 4627.
- 2.2.2 Used 6 ft. along east side of Basin due to reports of cracking of liner and damage due to high winds along east shore.
- 2.2.3 Extension of 6 ft. to include southeast corner from 3/23,24 meeting.
- 2.2.4 Continue to north to 'low-point' to provide "self-draining."
- 2.2.5 Note excavation as a "guide" on plans per 3/23,24 meeting.

2.3 Limits of 6 in. excavation to be interior of Basin 'F' berms.

2.4 Rip-rap quantity requested but not received; quantity based on 24" thickness.

* obtained in 1/5/87 telephone conversation w/COE

Ckd By: BRL
4/87

3. GRADING

The grading of the Basin area was based on the following parameters:

1.1 Remove existing Basin 'F' berms/levees*
1.2 Drainage to the North-Northwest due to topography (minimizes earthwork)*
1.3 Balance Cut/Fill
1.4 Provide a "Self-Draining" area that minimizes 'Old Basin F' appearance*

* COE input

Ckd By: BKL
4/87

4. CLAY CAP/TOP SOIL

The thickness of the Clay Cap and Top Soil for Basin 'F' proper was established by the COE at the 3/23,24 meeting:

4.1 Clay Cap thickness to be 1 ft.
4.2 Top Soil thickness to be 6 in.
4.3 COE to provide Borrow Sources for clay and top soil.

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4/87

5. NORTH SURFACE IMPOUNDMENT

The North Surface Impoundment (lagoon) is to contain runoff (non-leachate) waters from Basin 'F' per COE direction and to have a single HDPE liner on a prepared foundation. The minimum volume of the impoundment is based on the following parameters:

5.1 6 mo. construction period (Dec. - May)

5.2 Entire basin (93 A.) open for first 2 mo. followed by 25% closure per mo. for next 4 mos.

5.3

Month	Ave. Precip.	Ave. Evap.
December	0.55 in.	1.1 in.
January	0.61 in.	1.1 in.
February	0.69 in.	1.4 in.
March	1.21 in.	2.4 in.
April	1.81 in.	3.2 in.
May	2.47 in.	4.1 in.
	7.34 in.	13.3 in.

5.4 Runoff Volume (100% runoff assumed)

December = 0.55 in. (93 A.)(43,560)(7.48)/12 = 1.4 M.G.
January = 0.61 in. (93A)(43,560)(7.48)/12 = 1.5 M.G.
February = 0.69 in. (93)(.875)*(43,560)(7.48)/12 = 1.5 M.G.
March = 1.21 (93)(.625)*(43,560)(7.48)/12 = 1.9 M.G.
April = 1.81 (93)(.375)*(43,560)(7.48)/12 = 1.7 M.G.
May = 2.47 (93)(.125)*(43,560)(7.48)/12 = 0.8 M.G.

8.8 M.G.

5.5 Evap. from pond (assume 300' x 300' surf.)
13.3 (300 x 300)(7.48)/12 = 0.7 M.G.

5.6 Precipitation on pond (300' x 300')
7.34 (300 x 300)(7.48)/12 = 0.4 M.G.

5.7 Impoundment Vol. = 8.8 + 0.4 - 0.7 = 8.5 M.G.

* assumes mid-month

Ckd By: BKL
4/87

6. LEACHATE SURFACE IMPOUNDMENT

The leachate surface impoundment (lagoon) adjacent to the Waste Pile is to contain runoff from the Waste Pile interior and to have available storage for leachate generation from Waste Pile. Same precipitation/evaporation parameters as North Impoundment. Six month construction period with 2 subcells filled per month. Additional information regarding leachate is anticipated from bench scale testing results which may have an impact on surface impoundment sizing.

6.1 Runoff Volume (100% runoff assumed)

Dec & Jan = (.55 + .61)(250' x 700')(2.5)*(7.48)/12 = 0.3 M.G.
Feb & Mar = (.69 + 1.21)(250' x 700')(1.5)*(7.48)/12 = 0.3 M.G.
Apr & May = (1.81 + 2.47)(250' x 700')(0.5)*(7.48)/12 = 0.2 M.G.

0.8 M.G.

6.2 Precipitation-Evaporation in Pond

(7.34 in. - 13.3 in.)(150' x 150')(7.48)/12 = 0.1 M.G. evap

6.3 Vol. Available for Leachate = 1.5** - 0.8 + 0.1 = 0.8 M.G.

* subcells open
** 1.5 M.G. Pond assumed

Ckd By: BRL
4/87

7. BASIN 'F' DRAINAGE SIZING

The runoff potential from Basin 'F' that could be expected at the southern berm of Basin 'F' as determined using the Colorado Urban Hydrograph Procedure (CUHP) and the following parameters:

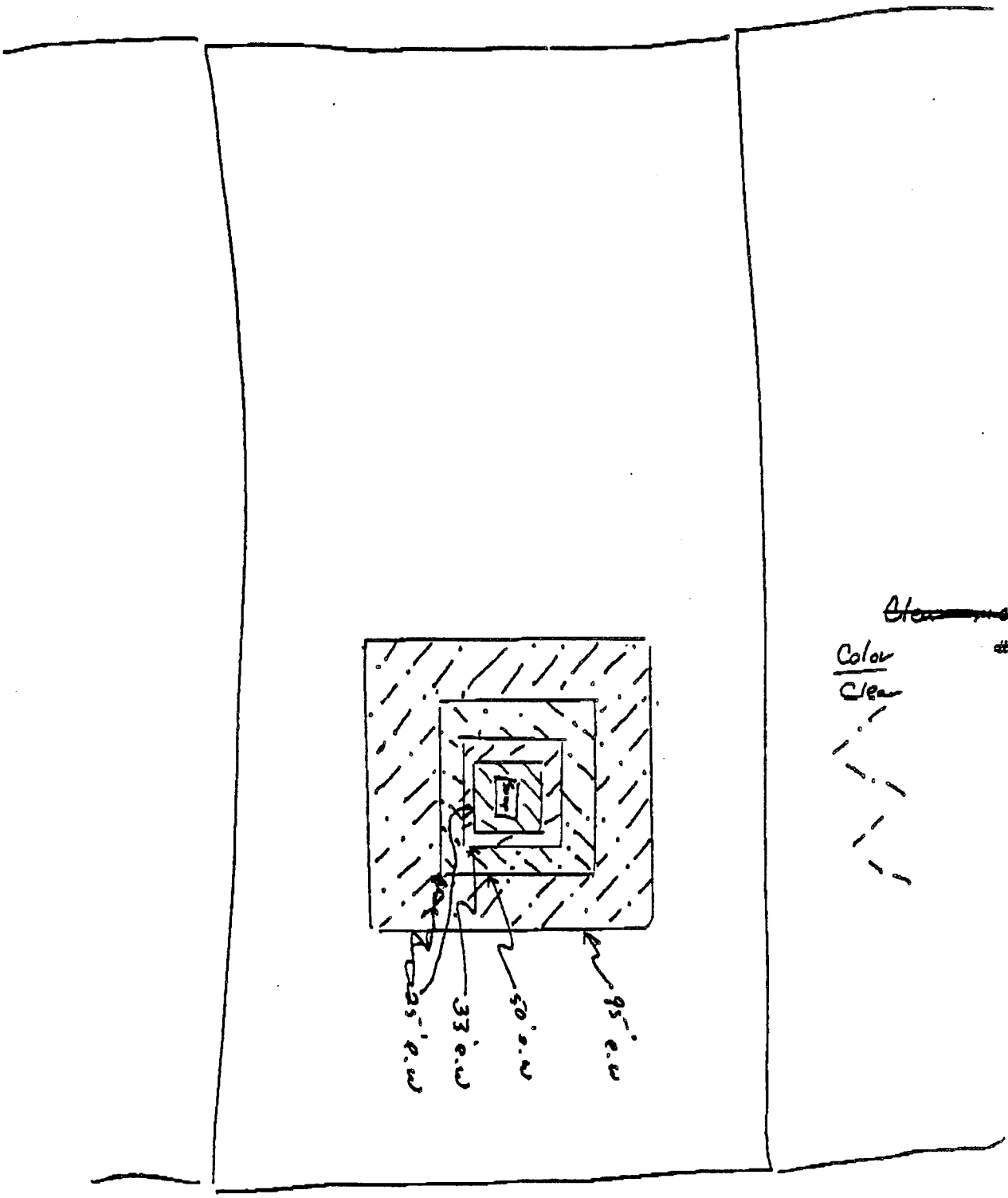
7.1 Drainage Area = 1.05 Sq. Mi.
7.2 Diversion south of Basin 'F' to fail and allow all flows to Basin 'F'
7.3 100 yr. Frequency
7.4 100 yr. Peak Flow = 570 cfs (see attached hydrograph)
7.5 Channel Design

7.5.1 Slope = 1'/350' = 0.3%
7.5.2 Max. Channel Depth = 5' (assumed)
7.5.3 5:1 Side Slopes, 50' Bottom
7.5.4 1' Slope to Center
7.5.5 Area = 5 x 50 + 5 x 25 + 1 x 25 = 400 S.F.
7.5.6 WP = 50 + 2(25.5) = 101 ft.
7.5.7 R = 400/101 = 3.96
7.5.8 n = 0.035
7.5.9 $Q = (1.486/035)(400)(3.96)^{2/3}(.003)^{1/2} = 2,328$ cfs
7.5.10 V = 2,328/400 = 5.8 fps

Chk by EWG

Project Basin F | Computed RTS

Subject Geonet Multiple Layers | Date 4-9-87 | Sht. 1 | Of



Detail "X"
Typical Geonet Layout at Sump
NTS

Project Basin F 4008-02-34 | Computed RT Sprague
Subject Waste Pile | Date 4-7-87 | Sht. 1 | Of 11

Basis of Design

A. Design Criteria Summary

1. Dimensions — 700 ft x 750 ft x 35 ft
2. Settlement — < 2 ft
3. Slope — 4:1
4. non-RCRA Design
5. Multiple Subcells — (3 each)
6. Geomembrane is HDPE — 60-mils thick
7. Leachate equals precipitation — (20"/yr)
8. Cap

B. Waste Pile Dimensions (by others)

1. 750 ft x 700 ft — inside toe of dike
2. ± 35 ft depth, including cap
3. 4 to 5 ft drop SW to NE (topography)

C. Settlement

1. Calculate loading for settlement & for drainage layer

a. Assume: waste density ρ_w = 125 pcf
cap soil density ρ_c = 100 pcf average

b. 125 pcf x 32 ft = 4000 psf

100 pcf x 2.5 ft = 250 psf

4250 psf

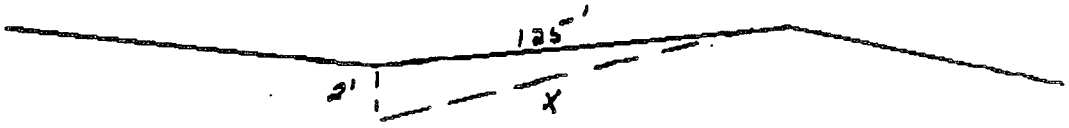
say 4500 psf

2. Assume settlement less than 2ft (by WCC)
Settlement calculated by WCC = 13 inches at Waste Pile base. DJH

3. Calculate geomembrane elongation

a. assume: Geomembrane (GM) is HDPE (see below)
Failure occurs at yield elongation, $\varepsilon = 10\%$
3 Subcells, GM "tied" at crests and at sump, GM floats free between

b. first approximation



$$X \doteq \sqrt{125^2 + 2^2} = 125'.016 \text{ ft}$$

$$\frac{(125'.016 - 125')}{125} << 10\%$$

no further calculation required

⇒ Since Actual settlements estimated by WCC are less than 2 feet, analysis is satisfactory

D. Slope Stability (+)

1. Calculate stable angle of repose for cap

a. assume: Multiple layer cap (see below)
Soil is silty sand (SM, ML, SC)
$c = 0.1 \text{ kg/cm}^2$
$\phi = 30°$
Soil - Geotextile
$c_a = 0.05 \text{ kg/cm}^2$
$\delta = 27°$ (Eff = 90%)

Chk by EWG

Project Basin F | Computed RTS

Subject | Date 4-7-87 | Sht. 3 | of 11

b. @ 4:1 $\delta_d = 22.5°$

$$F_S = \frac{\tan\delta}{\tan\delta_d} = \frac{\tan 27°}{\tan 22.5°} = 1.23$$

Factor of safety of 1.23 is marginally acceptable for a short term waste pile

2. Calculate shear forces on geotextile

a. assume: geotextile tensile, σ = 135 ppi = 1620 ppf
geotextile - geonet - geomembrane
$C_a = 0.0175 \text{ kg/cm}^2$
$\delta = 11°$

b. @ 4:1 Shear forces:

$S_a = W \sin\beta$
$= \gamma HL \sin\beta$
$= (100 pcf)(2.5 ft)(62 ft) \sin 22.5°$
$= 5806$ ppf

resisting forces:

$S_r = \sigma + C_a L + W \cos\beta \tan\delta$

$= 1620$ ppf $+ (36 psf)(62 ft) +$

$(100 pcf)(2.5 ft)(62 ft) \cos 22.5° \tan 11°$

$= 6636$ ppf

$$F_S = \frac{6636}{5806} = 1.13$$

Chk by RWG

Project Basin F | Computed RTS

Subject | Date 4-7-87 | Sht. 4 | Of 11

E. non-RCRA Design

1. per RMA & ACOE instructions since temporary waste pile

2. Cross Section (Bottom to Top)

a. Foundation = Native Soil
b. Geomembrane = 60-mil HDPE
c. Leachate Collection
   i. Geonet = 200-mil HDPE
   ii. Geotextile filter = 12 oz. Geotextile
d. ~~Working Face~~ Soil layer = 10^{-4} to 10^{-5} cm/sec Misc. Fill
e. Hazardous Waste
f. ~~Working Face~~ Soil layer = 10^{-4} to 10^{-5} cm/sec Misc. Fill
g. ~~Gas Collection~~
   i. ~~Geotextile~~ = ~~12 oz. Geotextile~~
   ii. ~~Geonet~~ = ~~150 to 250-mil HDPE~~
h. Geomembrane = 60-mil HDPE
i. Precipitation Collection
   i. Geond = 150 to 250-mil HDPE
   ii. Geotextile = 12 oz. Geotextile
12" soil layer →
j. ~~Soil~~ ~~Cap~~ Cohesive cover
k. Top Soil

3. Geotextile should be poly propylene since leachate pH may be high due to addition of fly ash. Polyester geotextiles may be effected by high pH, especially with divalent cations.

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Project Basin F | Computed RTS

Subject | Date 4-2-87 | Shr. 5 | Of 11

F. Multiple Subcells

1. Advantages
   a. Allow partial closure; therefore, minimize leachate production from precipitation.
   b. Isolate portions of liner; therefore, isolate leaks.
   c. More easily extended as discrete compartments.
2. Disadvantages
   a. More difficult to construct
   b. More detailed welding; therefore, more potential for leaks in faulty welds.

3. For Basin F, we evaluated 8, 6, 5, 4, 3, 2 & 1 subcell systems in various configurations
   a. with ≥ 4 subcells, cannot close subcell until next subcell is nearly complete @ 4:1 sideslopes
   b. selected 3 subcells as compromise between closing subcells quickly and maximum number of subcells.
   c. also selected 3 subcells as largest size easily drained by one layer of geonet

G. Geomembrane Selection

1. The standard liners in Hazardous Waste Landfills are 60-mil or 80-mil HDPE
2. HDPE liners have passed chemical compatibility testing (USEPA method 9090) against leachate from numerous Chemical Waste Mgmt, Inc & BFI Hazardous Waste Landfills.
3. HDPE was the only material which survived one year of exposure to six chemical solutions in a comprehensive USBR/USEPA study.
4. 100-mil HDPE can be difficult to install; 60-mil & 80-mil generally are easier to install "leak-free"

5. 60-mil HDPE was specified by CCC

Project Basin F Computed RTS

Subject Date 4-7-87 Chk. C Sh. 11

H. Leachate Collection System

1. Calculate leachate production

a. Assume: solidified waste contains no "free" water (somewhat harsh)
evaporation equals zero (conservative)
∴ leachate equals precipitation

b. Annual precipitation is approximately 16 in/yr

Say 20 in/yr (conservative)

$$\left(20\ \frac{in}{yr}\right)\left(2.54\times10^{-2}\ \frac{m}{in}\right)\left(\frac{1\ yr}{365\ d}\right)\left(\frac{1\ d}{24\ hr}\right)\left(\frac{1\ hr}{3600\ sec}\right) = 1.61\times10^{-8}\ m/sec$$

c. Storm event

10yr - 24hr = 3.1 in = 9.11×10^{-7} m/sec

almost two orders of magnitude higher.

d. Since design for 10yr - 24hr storm would be expensive, use moderate permeability soil to slow permeation into leachate collection layer, and cap ASAP.

2. Leachate Collection Capacity

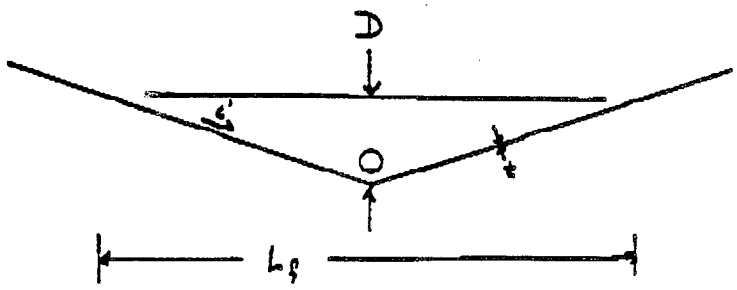
a. Assume: Maximum head on liner $D = 1$ ft
Geonet thickness $t = 200$ mil
$= 5\times10^{-3}$ m
Geonet transmissivity $T = 6\times10^{-4}$ m²/sec
(includes $F_S = 5$ @ 4000 psf)
Minimum slope $i = 2\%$
$= 0.02$ m/m

ckd by EWG

Project Basin F | Computed RTS

Subject | Date 4-7-87 | Sht. 7 | of 11

b.



where: $L_f = 2 \times \frac{1 ft}{0.02} = 100 ft = 30.5 m$

c. Maximum flowrate (perpendicular to cross-section in b.)

$Q = K \cdot i \cdot A$ (Darcy Equation)

where: $A = L_f \cdot t = (30.5 m)(5 \times 10^{-3} m)$
$= 1.56 \times 10^{-1} m^2/layer$

$K = \frac{T}{t} = \frac{6 \times 10^{-4} m^2/sec}{5 \times 10^{-3} m} = 1.18 \times 10^{-1} m/sec$

$\therefore Q = \frac{K \cdot i \cdot A}{FS} = \frac{(1.18 \times 10^{-1})(0.02)(1.56 \times 10^{-1})}{FS}$

$= \frac{3.67 \times 10^{-4} m^3/sec/layer}{FS}$

$= 3.67 \times 10^{-4} m^3/sec/layer$ if $FS = 1$

3. Calculate Subcell size based on single layer of geonet

a. Assume: precipitation 9 of 12 months

b. $q = (1.61 \times 10^{-8} m/sec)(12/9) = 2.15 \times 10^{-8} m/sec$

c. $A = \frac{Q}{q} = \frac{3.67 \times 10^{-4} m^3/sec}{2.15 \times 10^{-8} m/sec} = 17,070 m^2$

$= 700 ft \times 260 ft$

say 700 ft x 250 ft or 3 Subcells

4. Calculate area requiring multiple layers of geonet

a. assume: multiple layers required as troughs approach sump ($L_s < 100$ ft)

use $n t = \frac{A}{L_x}$

where: n = number of layers
$t = 5 \times 10^{-3}$ m/layer
$A = 1.56 \times 10^{-1}$ m² (from 2. above)
L_x = flow width

n	L_x	
1	>95'	
2	95'	
3	58'	
4	33'	
5	25'	← practical limit
6	20'	
7	17'	

5. Calculate Sump Volume

a. assume: Sump and leachate collection system cannot be sized to accomodate major storm event at construction budget.
Sump design, therefore, to accomodate average conditions and "typical event"
Granular fill porosity = 0.5
$K = 10^{-2}$ cm/sec = 3.3×10^{-4} ft/sec
300-mil PE sheet maximum dimensions 6' x 15'

b. Maximum working depth with 1 ft reinforced concrete

6 - 1 = 5 ft

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Project Basin F | Computed RTS

Subject | Date 4-9-87 | Sht. 9 | of 11

c. Calculate minimum pump capacity

assume: "typical event" = $\frac{20\ in/yr}{60\ events/yr}$ = 0.33 in/event

remove within 24 hours

$(0.33\ in)\left(\frac{250' \times 250'}{43{,}560\ ft^2/ac}\right)(27154\ gal/ac\text{-}in) = 36{,}200\ gal/event$

$\frac{36{,}200\ gal/24\ hr}{1440\ min/24\ hr} = 25^{\pm}\ gpm$, min. w/ continuous operation

d. Calculate minimum area

assume: average gradient = $\frac{1}{2}D = 2.5\ ft/ft$

Darcy equation applies

let $\frac{Q}{A} = Ki$ set $Q = 25\ gpm$, pump rate

$\frac{25\ gpm}{A} = (3.3 \times 10^{-4}\ cm/s)(2.5)/FS$

$A = 68\ ft^2$ @ FS = 1

$A = 136\ ft^2$ @ FS = 2

say 11 ft x 11 ft

Chk by EWG

Project Basin F | Computed RTS

Subject | Date 4-9-87 | Sht. 10 | Of 11

I. Gas Collection System

1. NH_3 offgas may be a problem according to WES
2. No information on offgas quantity, release rate, etc
3. Use single layer of geonet, seats 100' o.c. since these are fairly standard in industry

J. Precipitation Collection Capacity

1. assume: Geonet thickness $t = 250\ mil = 6.3 \times 10^{-3}\ m$
   Geonet transmissivity $T = 2.4 \times 10^{-3}\ m^2/sec$
   (includes $F_S = 5$ @ 500psf)
   Minimum slope $i = 0.06$

2. for $\frac{Q}{A} = Ki$:

$$K = \frac{T}{t} = \frac{2.4 \times 10^{-3}\ m^2/sec}{6.3 \times 10^{-3}\ m} = 3.8 \times 10^{-1}\ m/sec$$

3. set $A_l = A_p$ where: A_l = Area in leachate collection sys.
   A_p = " " precipitation " "

$$\frac{Q_l}{K_l i_l} = \frac{Q_p}{K_p i_p}$$

$$\text{or } \frac{Q_p}{Q_l} = \frac{K_p i_p}{K_l i_l} = \frac{(3.8 \times 10^{-1})(0.06)}{(1.18 \times 10^{-1})(0.02)} = 9.66$$

and the precipitation collection system can transmit $10^{\pm}$ times the fluid (at maximum head = 1 ft)

Chk by EDG

Project Basin F | Computed RTS

Subject | Date 4-9-87 | Sht. 11 | Of 11

K. Erosion of Soil Cap

a. assume: $A = RKLSCP$, soil loss equation holds
where: $R = 60$, annual average for Denver Area
$K = 0.3$, moderately erodable top soil
$LS = 5.0$, for 25% slope, 62 feet long
$P = 1.0$, for little or no support practice
& $A \leq 1$% per year

b. weight of top soil

$$(0.5\text{-ft})(43560\ \text{ft}^2/\text{ac})(80\ \text{lb/cu.ft}) = 1.74\times10^6\ \text{lb/ac}$$

$$\frac{1.74\times10^6\ \text{lb/ac}}{2000\ \text{lb/ton}} \times 0.01/\text{yr} = 8.7\ \text{tons/ac/yr.}$$

c. $8.7 = (60)(0.3)(5.0)(1.0)\,C$

$C = 9.67\times10^{-2}$ say 0.10

for permanent grassland with little litter

$C = 0.1$ implies 50 to 60% ground cover which is reasonable with wheatgrass in Denver area

Subject LINER QUANTITY

Project No. 86C8554P

By D. HAWK Checked By RWG

Task No. 2

File No. 21947

Date 3/21/87 Date

Sheet 1 of 1

LANDFILL

TOP AREA	500 × 550 =	275,000 SF × 1.02 =	280,500
SIDE AREA	143.7' × 2720LF =	390,930 SF × 1.02 =	398,750
BOTTOM AREA	810 × 760 =	615,600 SF × 1.02 =	627,910

1,307,160 SF

DRAINAGE NETS

1	BOTTOM	= 627,910 × 1	=	627,910
2	TOPS	= 2 × 280,500	=	561,000
2	SIDES	= 2 × 398,750	=	797,500

1,986,410 SF

SYNTHETIC LINERS

1 BOTTOM
1 SIDE
1 TOP

} See above 1,307,160 SF

GEOTEXTILE NETS

1 BOTTOM
2 TOPS
2 SIDS

} SEE DRAINAGE NETS 1,986,410 SF

Woodward-Clyde Consultants

Chk by RWG

Project RMA - Basin F - w/ WC | Computed CAA

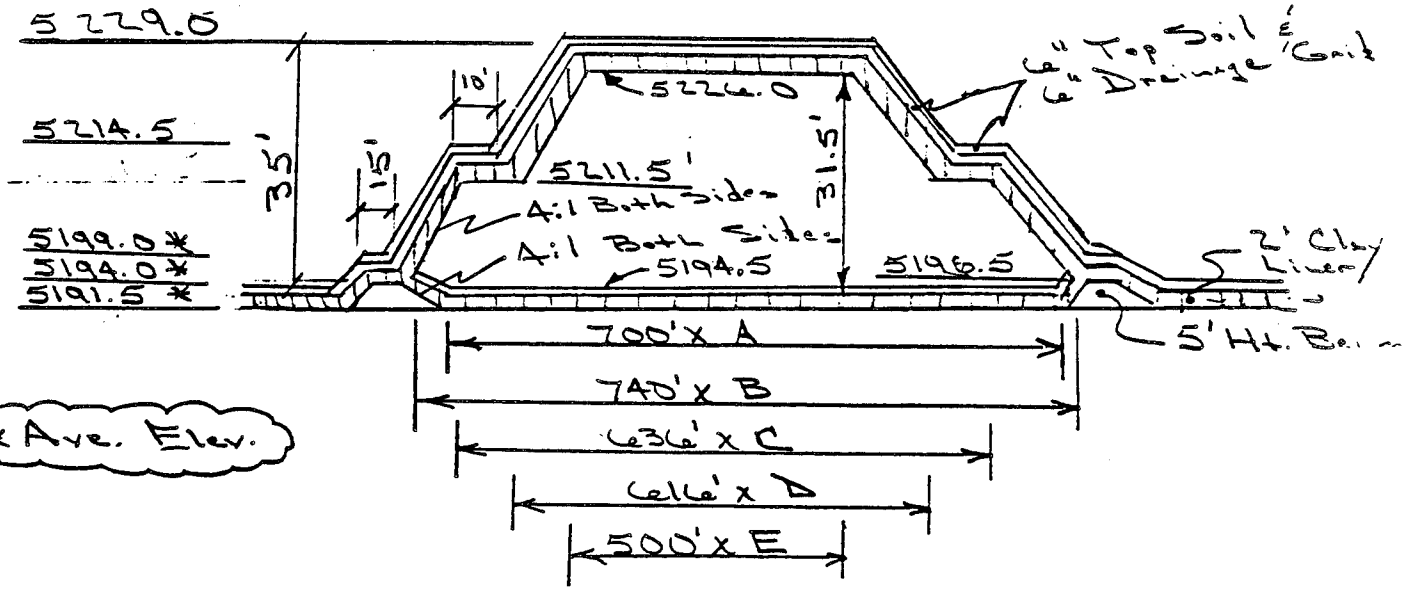
Subject Wastepile | Date 3/14/97 | Sht. 1 | Of 2

1) Design Parameters:

- 35 ft. height
- 5 ft. height berms, 4:1 slopes, 15 ft. top width
- 500,000 C.Y. material
- 2 ft. clay liner, bottom
- 1 ft. drainage grid
- 1 ft. cushion (will be "dirt" material)
- 2 ft. clay cap, top
- 1 ft. drainage grid and topsoil
- 700 ft. width on narrow end
- 10 ft. wide berm on wastepile @ halfway above containment berm
- Berm to be placed prior to clay liner; this yields 35 ft. ht. from finished grade on Basin F (at centerline of wastepile = 5194.0 avg.) for a top of wastepile elev. = 5,229.5

2) Wastepile Sizing

- Assume level bottom w/ wastepile center elev. used = 5191.5



* Ave. Elev.

B = A + 40'
C = A - 64'
D = A - 84'
E = A - 200'

$$Vol. = h/3\,(A_1 + A_2 + \sqrt{A_1 A_2})$$

A 150

Chk by BWC

Project: RMA-Basin F-WWC | Computed: CA

Subject: Wastepile | Date: 3/16/87 | Sht. 2 | Of 2

Try A = 725' (B = 765, C = calc, D = calc, E = 525)

$$V_1 = \frac{4}{3}\left[(700\times725)+(740\times765)+\sqrt{(700\times725)(740\times765)}\right]$$

$$= 2,146,133 \text{ C.F.} = 79,486 \text{ C.Y.}$$

$$V_2 = \frac{13}{3}\left[(740\times765)+(636\times calc)+\sqrt{(740\times765)(636\times calc)}\right]$$

$$= 6,388,782 \text{ C.F.} = 236,622 \text{ C.Y.}$$

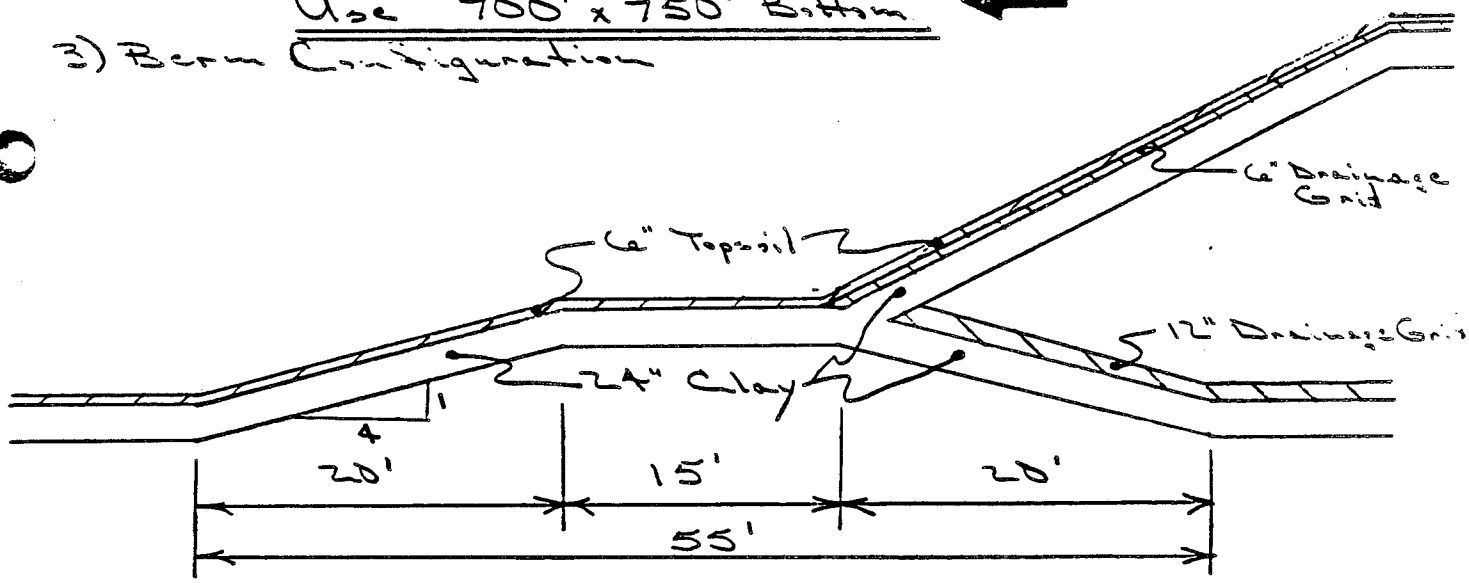
$$V_3 = \frac{14.5}{3}\left[(calc\times calc)+(500\times525)+\sqrt{(calc\times calc)(500)(525)}\right]$$

$$= 4,733,297 \text{ C.F.} = 175,307 \text{ C.Y.}$$

$$Vol_{700'\times725'} = \underline{491,415 \text{ C.Y.}}$$

Use 700' x 750' Bottom ◄

3) Berm Configuration



Wastepile Dimensions (Outside Edge) =
810' x 860'

Chk by EWG

Project | Computed

Subject | Date 3/87 | Sht. | Of

1. Hazardous Waste
   A. Top
   B. 14½'
      $V = H/3 \left[A_1 + A_2 + \sqrt{A_1 A_2} \right]$
   C.

2. Protective Soil Layer (Do as areas)
   A. Bottom (12")
   B. Cap(12")(Bottom) } Same
   C. Cap(12")(Top) }

3. Clay (Areal)

4. Top Soil (Areal)

TABLE 3–2
Typical Values of Permeability Coefficients

		PARTICLE SIZE RANGE				"EFFECTIVE" SIZE		PERMEABILITY COEFFICIENT—k		
		Inches		Millimeters						
		$D_{max.}$	D_{min}	D_{max}	D_{min}	D_{20} In.	D_{10} mm.	Ft./yr.	Ft./mo.	Cm./sec.
TURBULENT FLOW	Derrick STONE	120	36	—	—	48	—	100×10^6	100×10^5	100
	One-man STONE	12	4	—	—	6	—	30×10^6	30×10^5	30
	Clean, fine to coarse GRAVEL	3	¼	80	10	½	—	10×10^6	10×10^5	10
	Fine, uniform GRAVEL	⅜	1/16	8	1.5	⅛	—	5×10^6	5×10^5	5
	Very coarse, clean, uniform SAND	⅛	1/32	3	0.8	1/16	—	3×10^6	3×10^5	3
LAMINAR FLOW	Uniform, coarse SAND	⅛	1/64	2	0.5	—	0.6	0.4×10^6	0.4×10^5	0.4
	Uniform, medium SAND	—	—	0.5	0.25	—	0.3	0.1×10^6	0.1×10^5	0.1
	Clean, well-graded SAND & GRAVEL	—	—	10	0.05	—	0.1	0.01×10^6	0.01×10^5	0.01
	Uniform, fine SAND	—	—	0.25	0.05	—	0.06	4000	400	40×10^{-4}
	Well-graded, silty SAND & GRAVEL	—	—	5	0.01	—	0.02	400	40	4×10^{-4}
	Silty SAND	—	—	2	0.005	—	0.01	100	10	10^{-4}
	Uniform SILT	—	—	0.05	0.005	—	0.006	50	5	0.5×10^{-4}
	Sandy CLAY	—	—	1.0	0.001	—	0.002	5	0.5	0.05×10^{-4}
	Silty CLAY	—	—	0.05	0.001	—	0.0015	1	0.1	0.01×10^{-4}
	CLAY (30 to 50% clay sizes)	—	—	0.05	0.0005	—	0.0008	0.1	0.01	0.001×10^{-4}
	Colloidal CLAY ($-2\mu \leq 50\%$)	—	—	0.01	10Å	—	40Å	0.001	10^{-4}	10^{-9}

of soil in levees or earth dams prospect, the variation of k with permeability tests on remolded loose and fairly dense. It has against e values using a logarit for e, the semilog diagram will b tion of permeability with void pared with the effect of slight

Fig. 3–7. Effect of permeab turbulent flow.

on permeability. Hence ext minations for a few selected appropriate, since at other may be just different enou of several hundred percent ir

What may perhaps have is degree of saturation. A occupied by gravitational w rated, there are circumsta in partially saturated soil. the most common situatio

Chkd by EWO

Project BASIN F – EMA | Computed

Subject WASTE PILE SIZE | Date 3/87 | Sht. | Of

$A_1 = b_W$

$A_2 = b_W + 2zy$

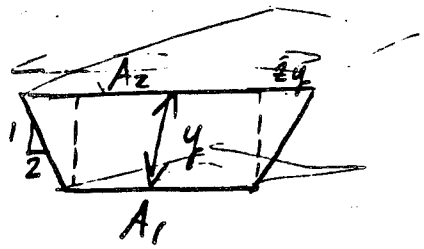
$A_2 = A_1 + 2zy$

$A_1 = A_2 - 2zy$

$$V = \frac{h}{3}\left(A_1 + A_2 + \sqrt{A_1 A_2}\right)$$

$$V = \frac{h}{3}\left(A_2 - 2zy + A_2 + \sqrt{(A_2 - 2zy)A_2}\right)$$

$$V = \frac{h}{3}\left(2A_2 - 2zy + \sqrt{A_2^2 - 2zyA_2}\right)$$



$z = 2$

$$V = \frac{y}{3}\left(2A_2 + 4y + \sqrt{A_2^2 - 4yA_2}\right) \leftarrow$$

(circled numbers 1–4 indicate the order of operations)

A in ft^2 V = ft^3

y in ft

min vol = 300,000 yd^3 = 8,100,000 ft^3

max = 1.6×10^6 yd^3 = 43,200,000 ft^3

$V = \frac{V}{43560}$ = ac-ft

Depth	Volume	Area	
10'	8,100,000 ft^2	809,993 ft^2	18.6 A
	43,200,000 ft^2	4,319,993 ft^2	99.2
20'	8,100,000 ft^2	404,987 ft^2	9.30
	43,200,000 ft^2	2,159,987 ft^2	49.6
30	8,100,000 ft^2	269,980 ft^2	6.20
	43,200,000 ft^2		
40	8,100,000	202,473	4.65
50	8,100,000	161,967	3.72
60	8,100,000	134,960	3.10
70	8,100,000	115,668	2.66
80	8,100,000	101,197	2.32

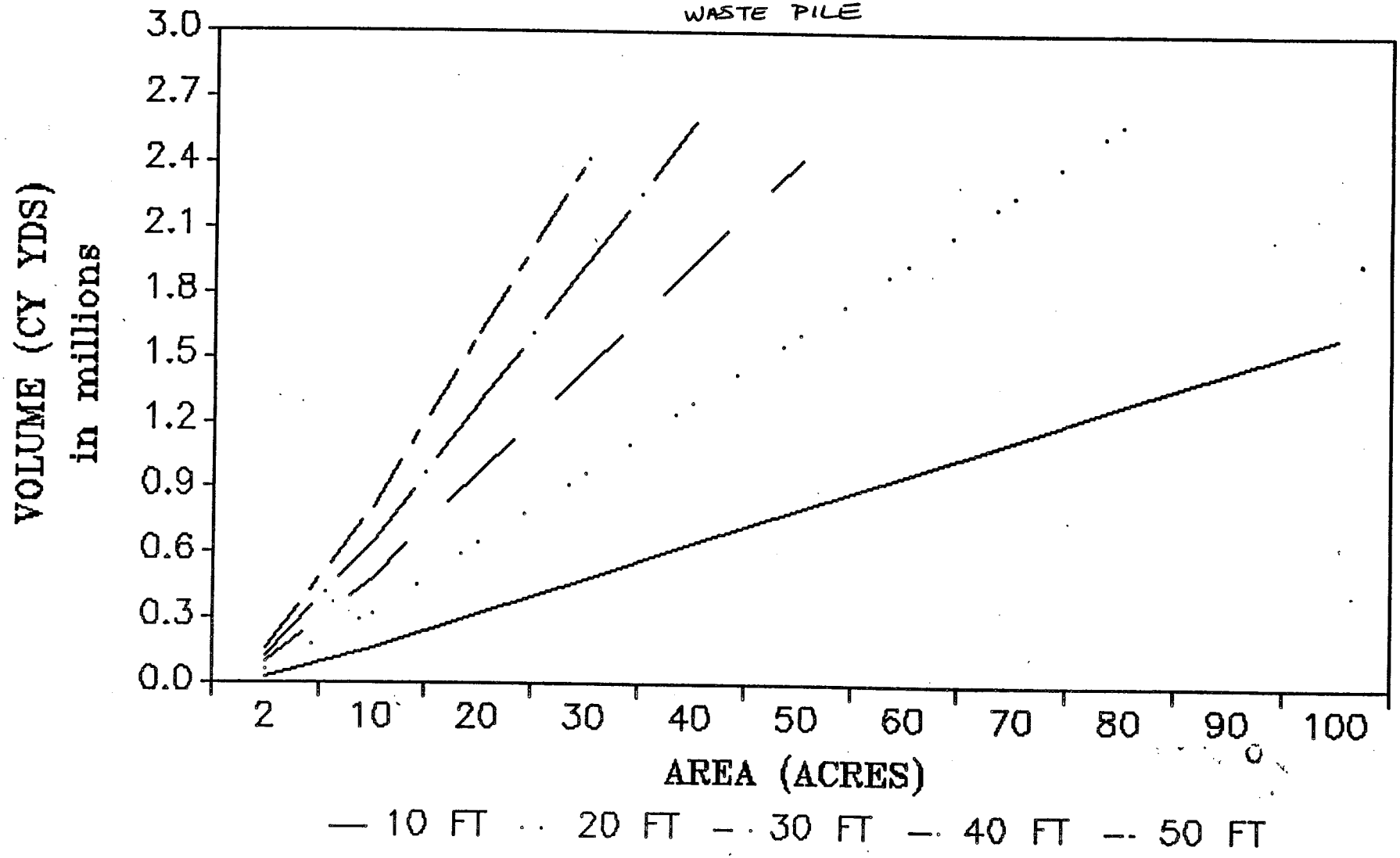
Depth	Volume	Area	
90	8,100,000	89,940 ft^2	2.06
100	8,100,000	80,933	1.86

Range 2A → 100 Ac

BASIN –F

VOLUME AND AREA AT VARIOUS DEPTHS

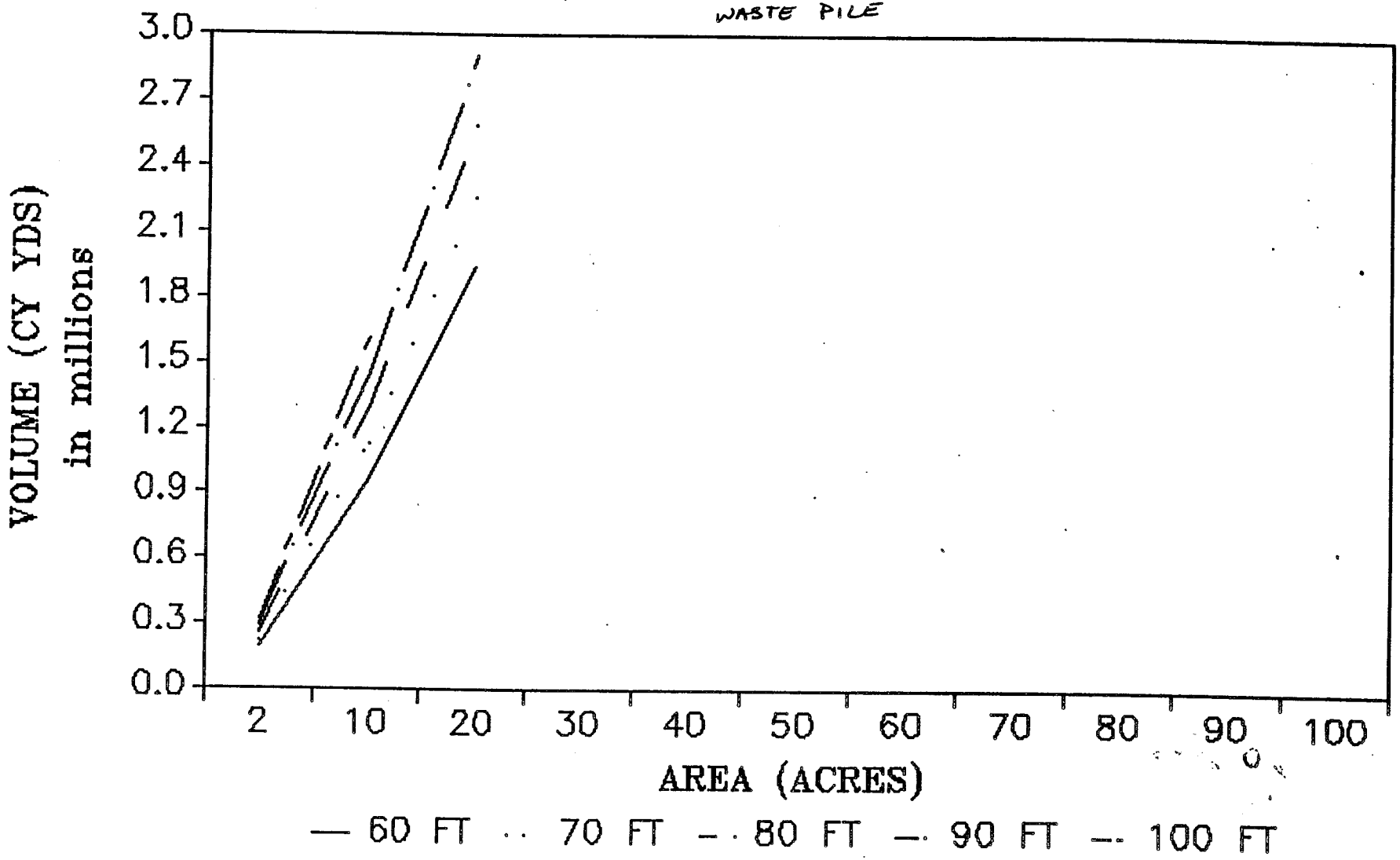
WASTE PILE

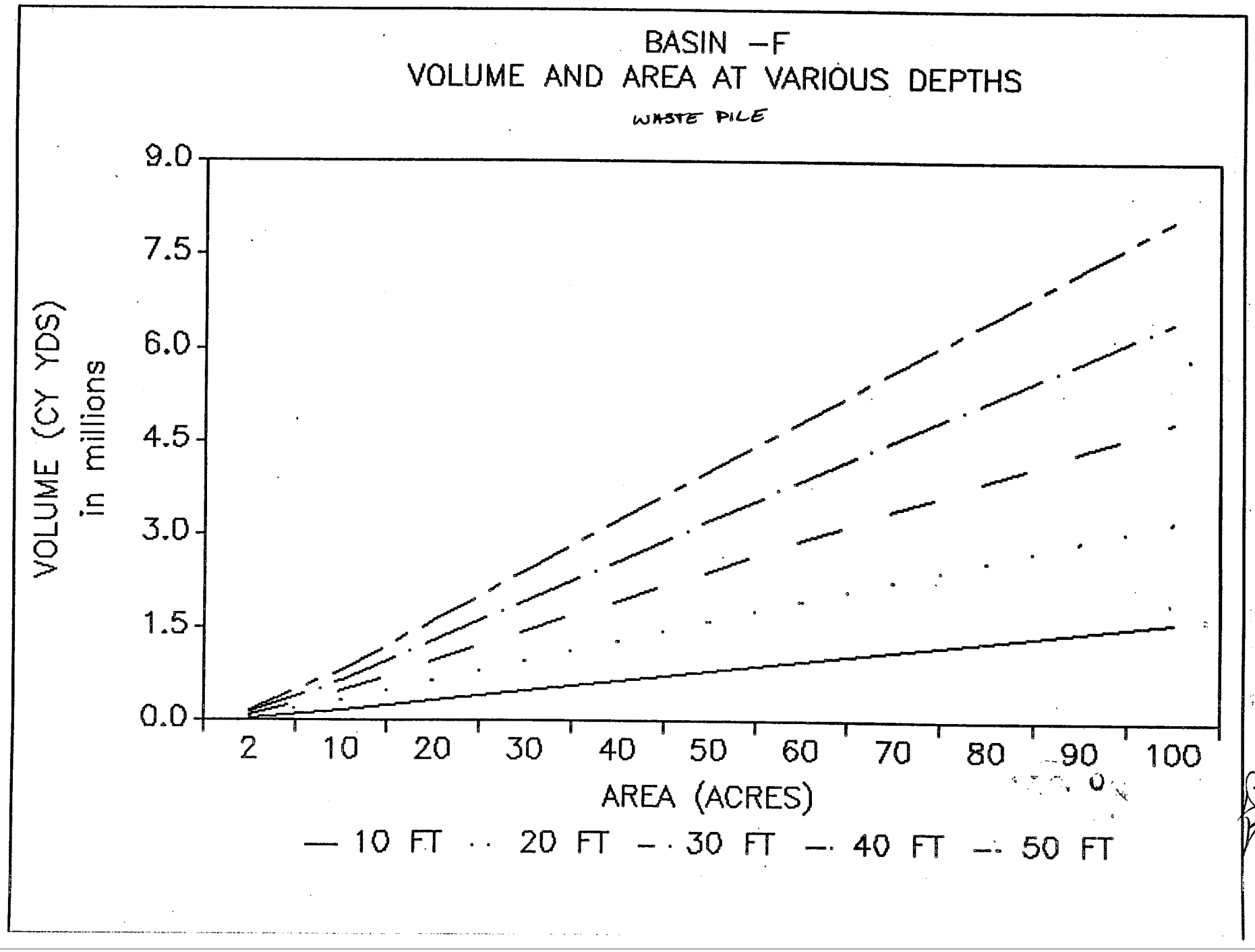


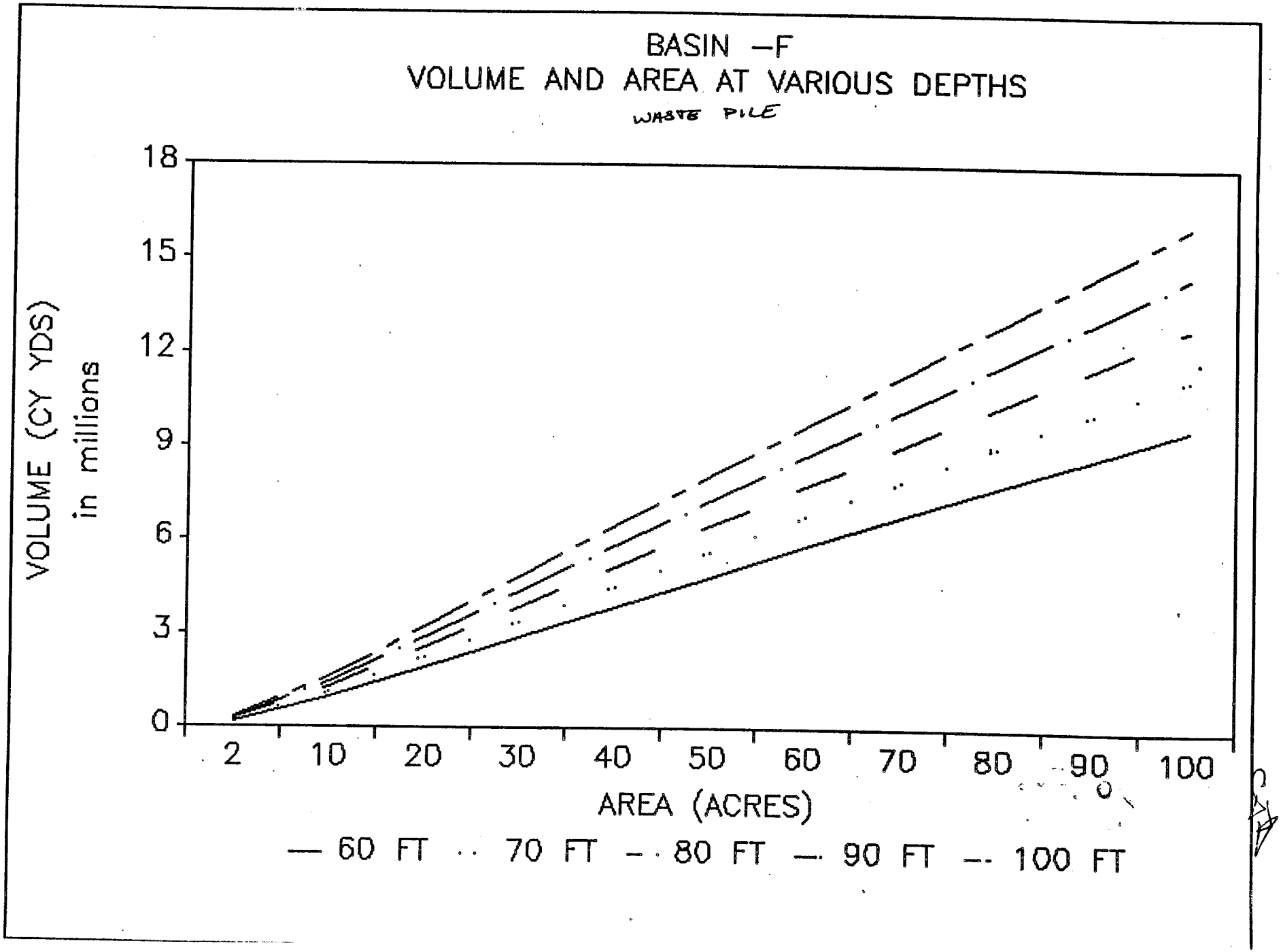
BASIN –F

VOLUME AND AREA AT VARIOUS DEPTHS

WASTE PILE




BASIN -F
VOLUME AND AREA AT VARIOUS DEPTHS
WASTE PILE
VOLUME (CY YDS)
in millions
9.0
7.5
6.0
4.5
3.0
1.5
0.0
2
10
20
30
40
50
60
70
80
90
100
AREA (ACRES)
— 10 FT · · 20 FT – · 30 FT — · 40 FT — · 50 FT


BASIN –F
VOLUME AND AREA AT VARIOUS DEPTHS
WASTE PILE
VOLUME (CY YDS)
in millions
18
15
12
9
6
3
0
2
10
20
30
40
50
60
70
80
90
100
AREA (ACRES)
— 60 FT .. 70 FT - · 80 FT — 90 FT –- 100 FT

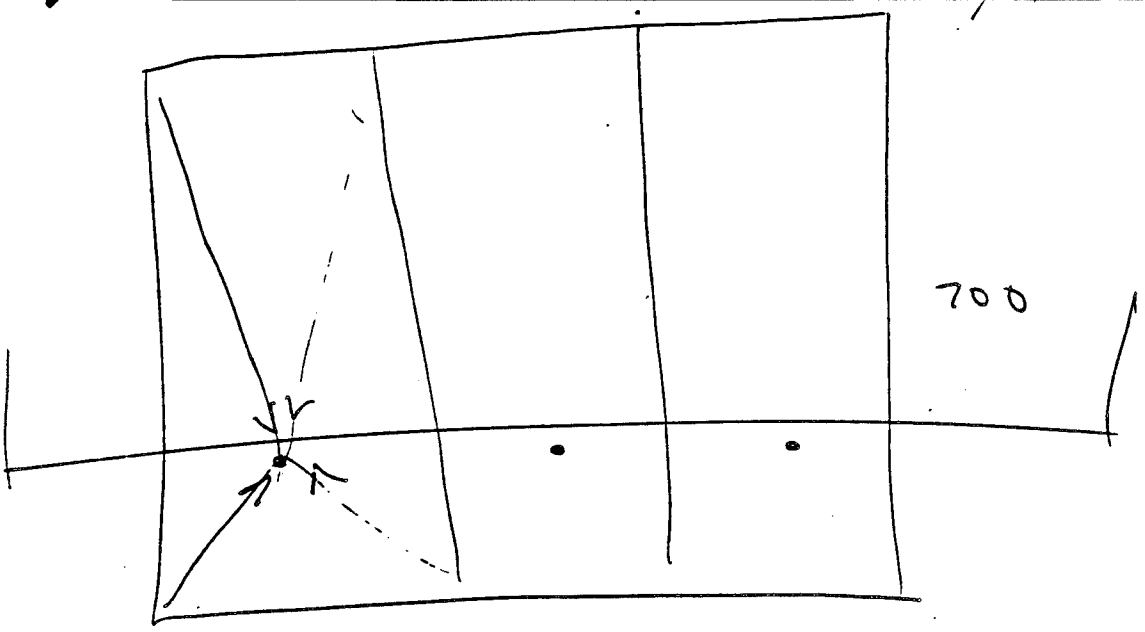
DEPTH FT	AREA AC	AREA FT**2	VOLUME AF	VOLUME YD**3
10	2	87,120	20	32,269.14
	10	435,600	100	161,335.80
	20	871,200	200	322,669.14
	30	1,306,800	300	484,002.47
	40	1,742,400	400	645,335.80
	50	2,178,000	500	806,669.14
	60	2,613,600	600	968,002.47
	70	3,049,200	700	1,129,335.80
	80	3,484,800	800	1,290,669.14
	90	3,920,400	900	1,452,002.47
	100	4,356,000	1,000	1,613,335.80
20	2	87,120	40	64,543.21
	10	435,600	200	322,676.54
	20	871,200	400	645,343.21
	30	1,306,800	600	968,009.88
	40	1,742,400	800	1,290,676.54
	50	2,178,000	1,000	1,613,343.21
	60	2,613,600	1,200	1,936,009.88
	70	3,049,200	1,400	2,258,676.54
	80	3,484,800	1,600	2,581,343.21
	90	3,920,400	1,800	2,904,009.88
	100	4,356,000	2,000	3,226,676.54
30.00	2	87,120	60	96,822.21
	10	435,600	300	484,022.22
	20	871,200	600	968,022.22
	30	1,306,800	900	1,452,022.22
	40	1,742,400	1,200	1,936,022.22
	50	2,178,000	1,500	2,420,022.22
	60	2,613,600	1,800	2,904,022.22
	70	3,049,200	2,100	3,388,022.22
	80	3,484,800	2,400	3,872,022.22
	90	3,920,400	2,700	4,356,022.22
	100	4,356,000	3,000	4,840,022.22
40.00	2	87,120	80	129,106.15
	10	435,600	400	645,372.84
	20	871,200	800	1,290,706.17
	30	1,306,800	1,200	1,936,039.50
	40	1,742,400	1,600	2,581,372.84
	50	2,178,000	2,000	3,226,706.17
	60	2,613,600	2,400	3,872,039.51
	70	3,049,200	2,800	4,517,372.84
	80	3,484,800	3,200	5,162,706.17
	90	3,920,400	3,600	5,808,039.51
	100	4,356,000	4,000	6,453,372.84
50.00	2	87,120	100	161,395.03
	10	435,600	500	806,728.39
	20	871,200	1,000	1,613,395.06
	30	1,306,800	1,500	2,420,061.73
	40	1,742,400	2,000	3,226,728.39
	50	2,178,000	2,500	4,033,395.06
	60	2,613,600	3,000	4,840,061.73
	70	3,049,200	3,500	5,646,728.39
	80	3,484,800	4,000	6,453,395.06
	90	3,920,400	4,500	7,260,061.73
	100	4,356,000	5,000	8,066,728.39

60.00	2	87,120	120	193,688.83
	10	435,600	600	968,088.88
	20	871,200	1,200	1,936,088.88
	30	1,306,800	1,800	2,904,088.88
	40	1,742,400	2,400	3,872,088.89
	50	2,178,000	3,000	4,840,088.89
	60	2,613,600	3,600	5,808,088.89
	70	3,049,200	4,200	6,776,088.89
	80	3,484,800	4,800	7,744,088.89
	90	3,920,400	5,400	8,712,088.89
	100	4,356,000	6,000	9,680,088.89
70.00	2	87,120	140	225,987.56
	10	435,600	700	1,129,454.30
	20	871,200	1,400	2,258,787.64
	30	1,306,800	2,100	3,388,120.98
	40	1,742,400	2,800	4,517,454.32
	50	2,178,000	3,500	5,646,787.65
	60	2,613,600	4,200	6,776,120.98
	70	3,049,200	4,900	7,905,454.32
	80	3,484,800	5,600	9,034,787.65
	90	3,920,400	6,300	10,164,120.99
	100	4,356,000	7,000	11,293,454.32
80.00	2	87,120	160	258,291.21
	10	435,600	800	1,290,824.66
	20	871,200	1,600	2,581,491.34
	30	1,306,800	2,400	3,872,158.02
	40	1,742,400	3,200	5,162,824.68
	50	2,178,000	4,000	6,453,491.35
	60	2,613,600	4,800	7,744,158.02
	70	3,049,200	5,600	9,034,824.69
	80	3,484,800	6,400	10,325,491.35
	90	3,920,400	7,200	11,616,158.02
	100	4,356,000	8,000	12,906,824.69
90.00	2	87,120	180	290,599.79
	10	435,600	900	1,452,199.96
	20	871,200	1,800	2,904,199.98
	30	1,306,800	2,700	4,356,199.99
	40	1,742,400	3,600	5,808,199.99
	50	2,178,000	4,500	7,260,199.99
	60	2,613,600	5,400	8,712,199.99
	70	3,049,200	6,300	10,164,199.99
	80	3,484,800	7,200	11,616,199.99
	90	3,920,400	8,100	13,068,200.00
	100	4,356,000	9,000	14,520,200.00
100.00	2	87,120	200	322,913.30
	10	435,600	1,000	1,613,580.19
	20	871,200	2,000	3,226,913.55
	30	1,306,800	3,000	4,840,246.89
	40	1,742,400	4,000	6,453,580.23
	50	2,178,000	5,000	8,066,913.57
	60	2,613,600	6,000	9,680,246.90
	70	3,049,200	7,000	11,293,580.24
	80	3,484,800	8,000	12,906,913.57
	90	3,920,400	9,000	14,520,246.91
	100	4,356,000	10,000	16,133,580.24

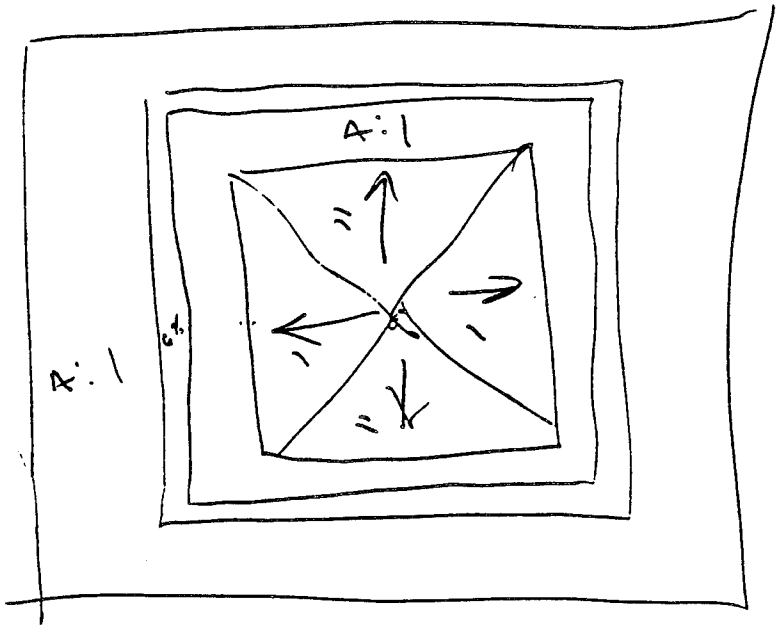
Chkd by KWG

Project | Computed

Subject | Date 3/97 | Sht. | Of



750



41

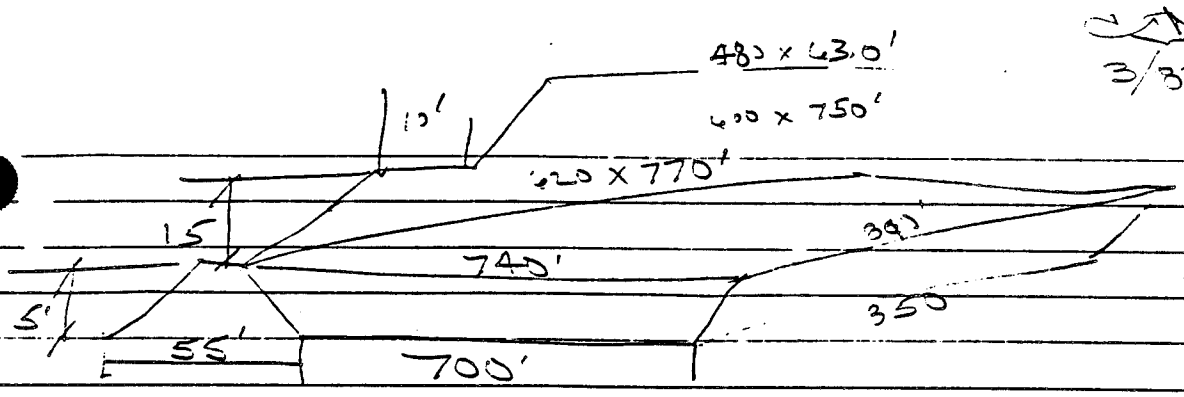
34

02

4.01

Chk by EWC

3/87



T-1 700' x 850'

$V_1 = \frac{5}{3}(595,000 + 658,600 + \sqrt{595,000 \times 658,600}) = 3,132,655$

$V_2 = \frac{15}{3}(658,600 + 477,400 + \sqrt{658,600 \times 477,400}) = 8,483,630$

$V_3 = \frac{15}{3}(450,000 + 302,400) + \sqrt{450,000 \times 302,400} = 5,606,451$

17,222,745

637,879 CY

T-1 ~~700 x 825~~ (740 x 865)

~~600 x 745~~ ~~700 x 730~~ 430 x 605)

$V_1 = \frac{5}{3}(577,500 + 640,100 + \sqrt{577,500 \times 640,100}) = 3,042,653$

$V_2 = \frac{15}{3}(640,100 + 441,000 + \sqrt{640,100 \times 441,000}) = 3,223,541$

$V_3 = \frac{15}{3}(435,000 + 290,400 + \sqrt{435,000 \times 290,400}) = 5,404,104$

11,670,298

617,600 CY

T-1 700 x 750 740 x 790

740 x 790 620 x 670

600 x 650 430 x 530

$\frac{5}{3}(525,000 + 584,600 + \sqrt{525,000 \times 584,600}) = 2,772,665$

$\frac{15}{3}(584,600 + 415,400 + \sqrt{584,600 \times 415,400}) = 7,463,954$

$\frac{15}{3}(390,000 + 254,400 + \sqrt{390,000 \times 254,400}) = 4,796,924$

15,033,543

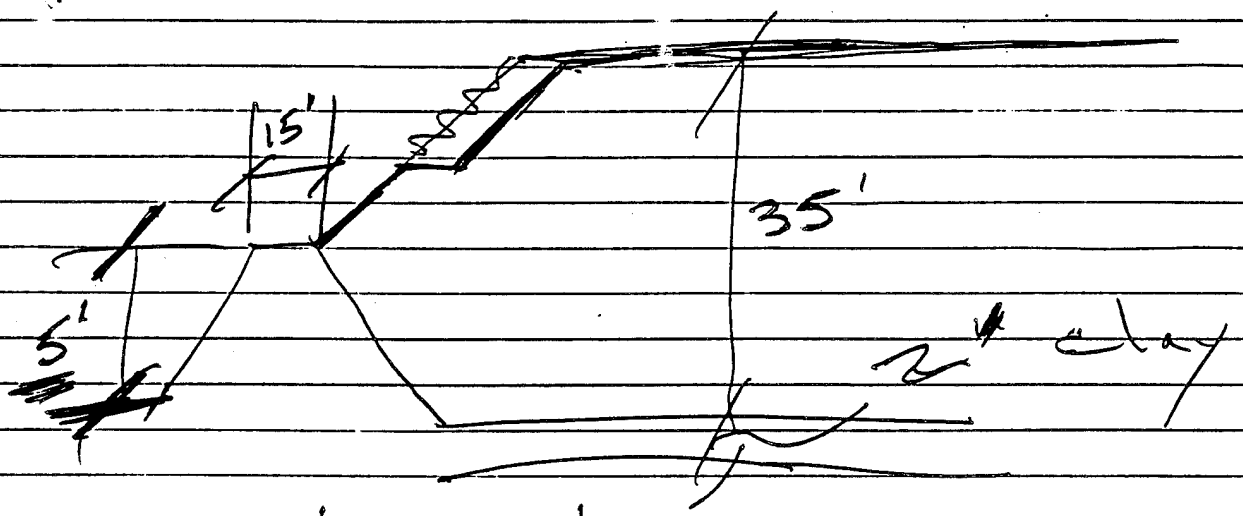
556,798 CY

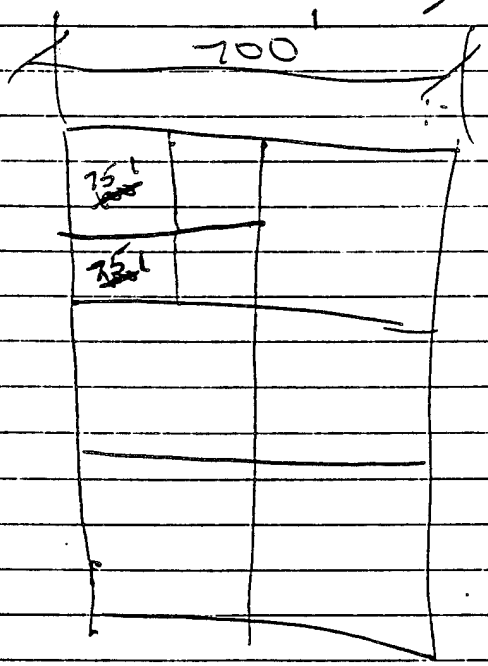
T-1 ~~700' x 725'~~	740 x 765	2,682,666	
740 x 765	620 x 645	7,208,988	
600 x 625	480 x 505	4,594,481	
		14,486,135	536,523
700 x 700	740 x 740	1,729,333	
740 x 740	620 x 620	6,954,000	
600 x 600	430 x 430	4,392,000	
		13,075,333	

484 CY

CA 3/37 click by click

1. Typical Shrinkage Factors





Chk by EWR

Project	Computed
Subject	Date 3/97 Sht. Of

Mix Ratio = ?

→ 10% +

35' max. Ht. @ ℄ Wastepile

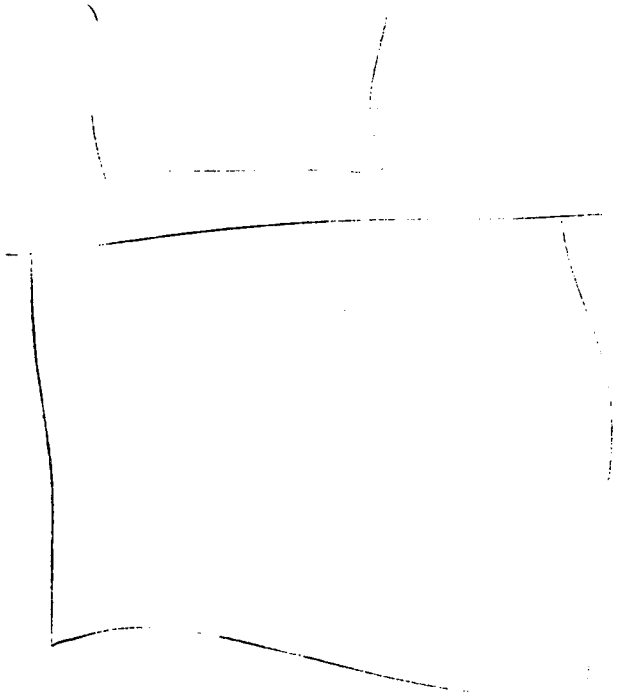
Need to know if liner / Overburden under Wastepile is to be left in place.

98% Due @ April 1±

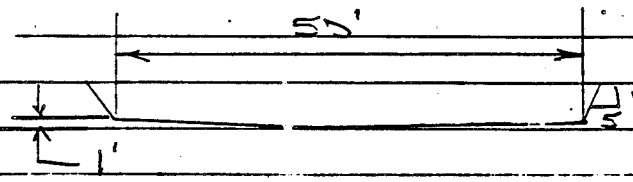
Lagoons →
FML
2' clay

200' x 200' or larger

Meeting @ 8701 Wed @ 11:15



$S = 1'/350' =$



CAT
3/37

Chk by
RWG

$A = 5 \times 50 + 1 \times 25 = 275$

$WP = 50 + 2(5.1) = 60.2'$

$R = 275/60.2 = 4.57$

$Q = \frac{1.486}{.035}(275)(4.57)^{2/3}(1/350)^{1/2} = 1,718 \text{ cfs} > 600$ OK

Chk by EWG

Project	Basin F	Computed	PHP
Subject		Date	1-21-87

Sht. | Of

$$G_s = \frac{\gamma_s}{\gamma_w} \Rightarrow \gamma_s = 2.6 \cdot 62.4 \frac{lbs}{ft^3} = .16 \frac{kips}{ft^3}$$

$$\gamma_s = \frac{W_s}{V_s} \Rightarrow V_s = \frac{W_s}{\gamma_s} = \frac{833,721 \text{ kips}}{.16 \text{ kips/ft}^3} = 5,210,756 \text{ ft}^3$$

4,263,350

$$e = \frac{V_v}{V_s} \Rightarrow V_v = e \cdot V_s = 0.4 \cdot 5,210,756 \text{ ft}^3$$

$V_v = 2,084,302. \text{ ft}^3$

1,705,340

assume degree of saturation $S_r = 75\%$

$$S_r = \frac{V_{LIQ}}{V_v} \Rightarrow V_{LIQ} = S_r \cdot V_v = 0.75 \cdot 2,084,302$$

$1,280,000 \text{ ft}^3$

$V_{LIQ} = 1,563,227 \text{ ft}^3$ ←

$(57,897 \text{ yd}^3)$ 10,[illegible] gal

$V_{GAS} = 521,075 \text{ ft}^3$ 4,800,000 gal

coefficient of permeability, K_v: .01 – 100 ft/yr

assume drainage by gravity $H = 25', 12.5'$

time factor for consolidation $T_v = 0.848$ 90%

$= 0.197$ 50%

coeff. of consolidation c_v: $\frac{T_v H^2}{t}$

$$c_v = \frac{K}{m_v \gamma_w}$$

Project Basin F | Computed PHP | Chk'd by RWC

Subject | Date 1-21-87 | Sht. | Of

coefficient of consolidation, c_v: $5 \cdot 10^{-3} - 1 \cdot 10^{-4}$ cm²/sec

$$1 \frac{cm^2}{sec} \cdot \frac{60 sec}{1 min} \cdot \frac{60 min}{1 hr} \cdot \frac{24 hr}{1 day} \cdot \frac{(1 in^2)}{(2.54 cm^2)} \cdot \frac{1 ft^2}{(144 in^2)}$$

$$= \underline{93} \quad ft^2/yr$$

$c_v = 0.47 - .01 \quad ft^2/yr$

for 90% consolidation: $T_v = 0.848$ 1-way drainage

$$t_{90} = \frac{T_v H^2}{c_v} = \frac{0.848 (25)^2}{.01} = 5.3 \cdot 10^4 yrs$$

$$= \frac{0.848 (25)^2}{.47} = 1127.7 yrs$$

modify c_v values

c_v: $1 - 10^{-2}$ cm²/sec
$93 - 1.0$ ft²/yr

$$t_{90} = \frac{.848 (25)^2}{1} = 530 yrs$$

$$t_{90} = \frac{.848 (25)^2}{93} = 5.7 yrs$$

Project Basin F | Computed PHP | chk by [illegible]

Subject | Date 1-21-87 | Sht. | Of

for 90% consolidation 2-way drainage

$$t_{90} = .848 \frac{(12.5)^2}{1} = 132.5 \text{ yrs}$$

$$t_{90} = .848 \frac{(12.5)^2}{93} = 1.42 \text{ yrs}$$

assume 25% of liquids will drain from fill

V_{DIS} .25 (1,563,227 ft^3) = 390,800 ft^3

V_{DIS} = 3,000,000 gallons (.9)

= 2,700,000 gallons

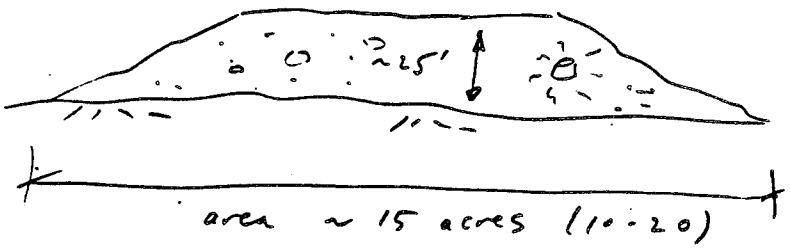
Project Basin F | Computed PHP | Chk by EWC

Subject | Date 1-20-87 | Sht. | Of

total volume of fill = 393,000 yd^3

ranges of "soil" properties:

		average
moisture content, w:	20 - 50 %	40.
total unit wt, γ_{TOT}:	100 - 120 pcf	~~110~~ 90.
void ratio, e:	0.2 - 1.0	
porosity, n:	0.2 - 0.5	
specific gravity, G_s =	2.5 - 2.7	2.6
degree of saturation, S_r =	50 - 100 %	75



V_{TOT} = 393,000 yd^3 = 10,611,000 ft^3

W_{TOT} = 10,611,000 ft^3 · (.110 ~~.90~~ $\frac{kips}{ft^3}$) = (1,167,210 ~~955,000~~ kips)

$\gamma_{dry} = \frac{\gamma_{TOT}}{1+w} = \frac{.11}{1+0.4} = (.08$ ~~.065~~ $kips/ft^3$ (80 pcf)

$\gamma_{dry} = \frac{W_s}{V_{TOT}}$ $\quad W_s = \gamma_{dry} \cdot V_{TOT} = (.08$ ~~.065~~ $\frac{kips}{ft^3} \cdot 10,611,000\ ft^3$

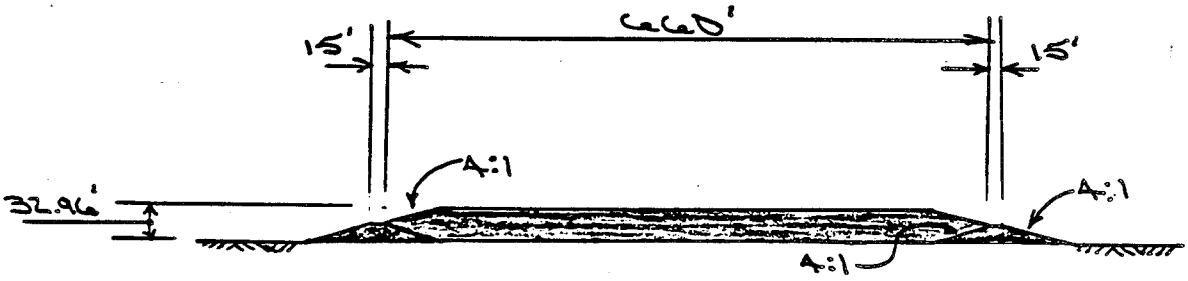
W_s = 833,721 kips

682,135

Chk by RWG

Project Basin 'F' | Computed

Subject Wastepile | Date 1/10/87 | Sht. 1 | Of 1



Sym. B.W.

Vol. act. = 393,258 C.Y. ⇒ Ht. = 29.26 Ft.

Vol. 10% Fly Ash = 432,584 C.Y. ⇒ Ht. = 32.96 Ft.

Widest Area = 10 A.

Vol. Fluid = 2,186,300 gal. (2,950,000 gal. from 10/23/8(letter; 2,830,000 gal. from 10/23/86 letter ave. depths & digitized areas)

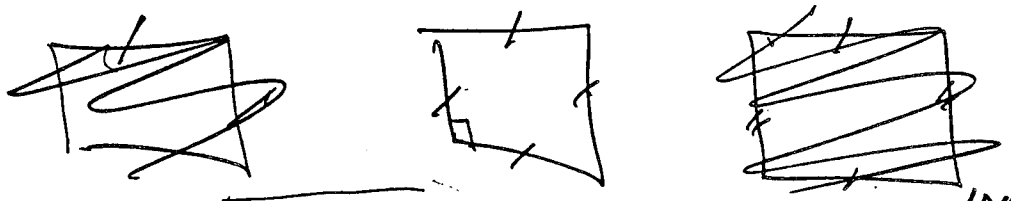
Chk by RWO

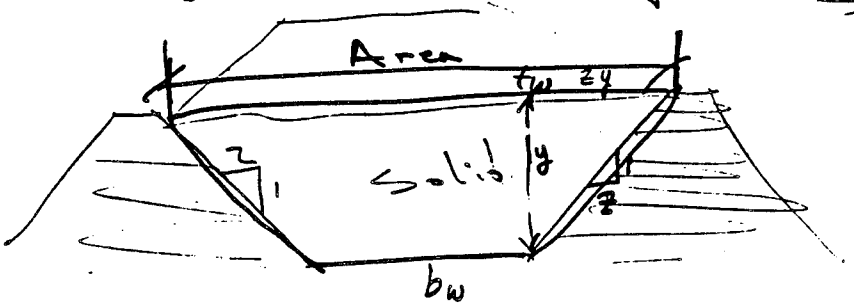
Project | Computed

Subject | Date 1/31 | Sht. | Of

min vol = 92A. x 2'

max vol = 92A. x 7' x 1.5





frustum of pyramid

$V = \frac{h}{3}(A_1 + A_2 + \sqrt{A_1 A_2})$

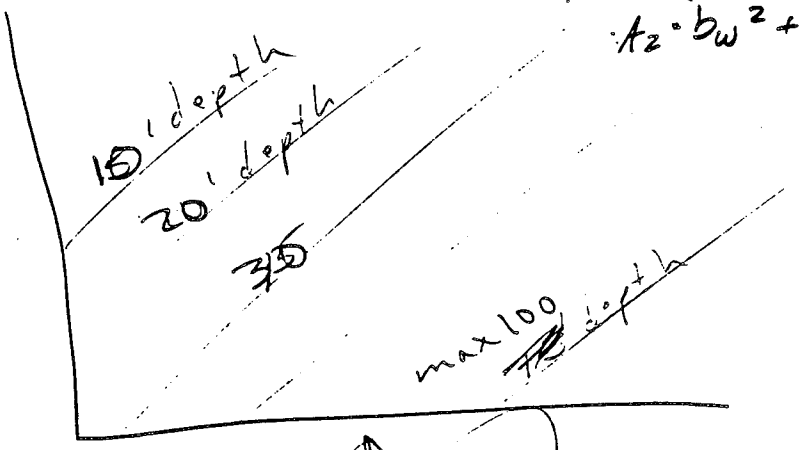
$A_1 = b_w^2$

$A_2 = t_w^2$ $t_w = b_w + 2zy$

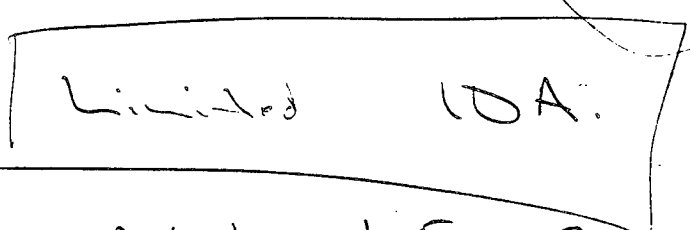
$A_2 = (b_w + 2zy)^2$

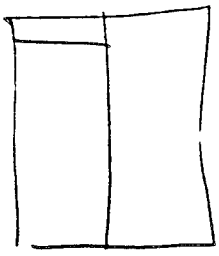
$A_2 = b_w^2 + 4zy + 4z^2y^2$

Vol



Area





Vol = 1.5M C.Y.

95' Ht.

Main! 4000-02-34 act. 24

d;40:

EARTH QUANTITIES

JOB: ROCKY MOUNTAIN ARSENAL

COMP BY CJA DATE 1/27

CHECKED BY RWJ DATE

EARTH Removal

STA.	DIST.	END AREA	SUM OF THE END AREA	DIST. COR	CUBIC YARDS
11+00	0	0	—	—	—
	1.0		1770	1770	
12+00		1770			
	1.0		3660	3660	
13+00		1890			
	"		4290	4290	
14+00		2400			
	"		4990	4990	
15+00		2590			
	"		5310	5310	
16+00		2720			
	"		5260	5260	
17+00		2540			
	"		5240	5240	
18+00		2700			
	"		5400	5400	
19+00		2700			
	"		5430	5430	
20+00		2730			
	"		5710	5710	
21+00		2980			
	"		5860	5860	
22+00		2880			
	"		5550	5550	
23+00		2670			
	"		5290	5290	
24+00		2620			
	"		5200	5200	
25+00		2580			
	"		5000	5000	
26+00		2420			
	"		4730	4730	
27+00		2310			
	"		4610	4610	
28+00		2300			

FLUIDS Removal

STA.	DIST.	END AREA	SUM OF THE END AREA	DIST. COR.	CUBIC YARDS
14+00		0			
	1.0		110		
15+00		110			
	"		370		
16+00		260			
	"		480		
17+00		220			
	"		310		
18+00		90			
	"		140		
19+00		50			
	"		61		
20+00		11			
	"		20		
21+00		9			
	"		26.5		
22+00		17.5			
	"		37.5		
23+00		20			
	"		70.5		
24+00		50.5			
	"		113.1		
25+00		62.6			
	"		257.6		
26+00		195			
	"		395		
27+00		200			
	"		450		
28+00		250			

EARTH QUANTITIES

JOB: _____

COMP BY _____ DATE _____

CHECKED BY _____ DATE _____

EARTH

STA.	DIST.	END AREA	SUM OF THE END AREA	DIST. COR	CUBIC YARDS
28+00		2300			
	1.0		4290	4290	
29+00		1990			
	"		4180	4180	
30+00		2190			
	"		4000	4000	
31+00		1810			
	"		3440	3440	
32+00		1630			
	"		3010	3010	
33+00		1380			
	"		2290	2290	
34+00		910			
	"		1290	1290	
35+00		380			
	"		380	380	
36+00		0			
			TOTAL	106,180	

106,180 x 1.85185 = 196,629.43

Say 196,629 C.Y.

* Based on 1"=5' Vert.

Earth = 393,258 C.Y.

FLUID.

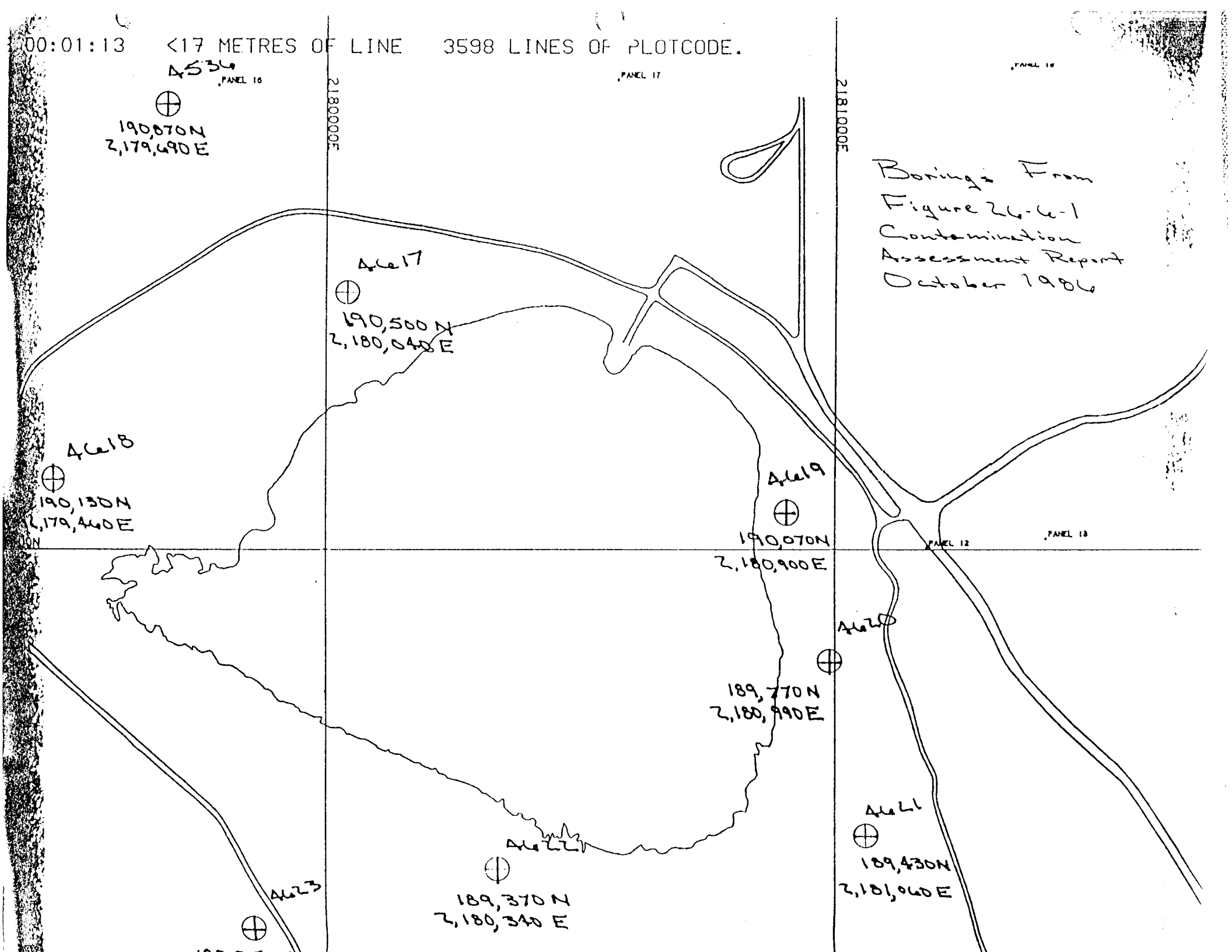
STA.	DIST.	END AREA	SUM OF THE END AREA	DIST. COR.	CUBIC YARDS
28+00		250			
	1.0		440	440	
29+00		190			
	"		420	420	
30+00		230			
	"		460	460	
31+00		230			
	"		510	510	
32+00		280			
	"		510	510	
33+00		230			
	"		230	230	
34+00		0			
		TOTAL		5411.2	

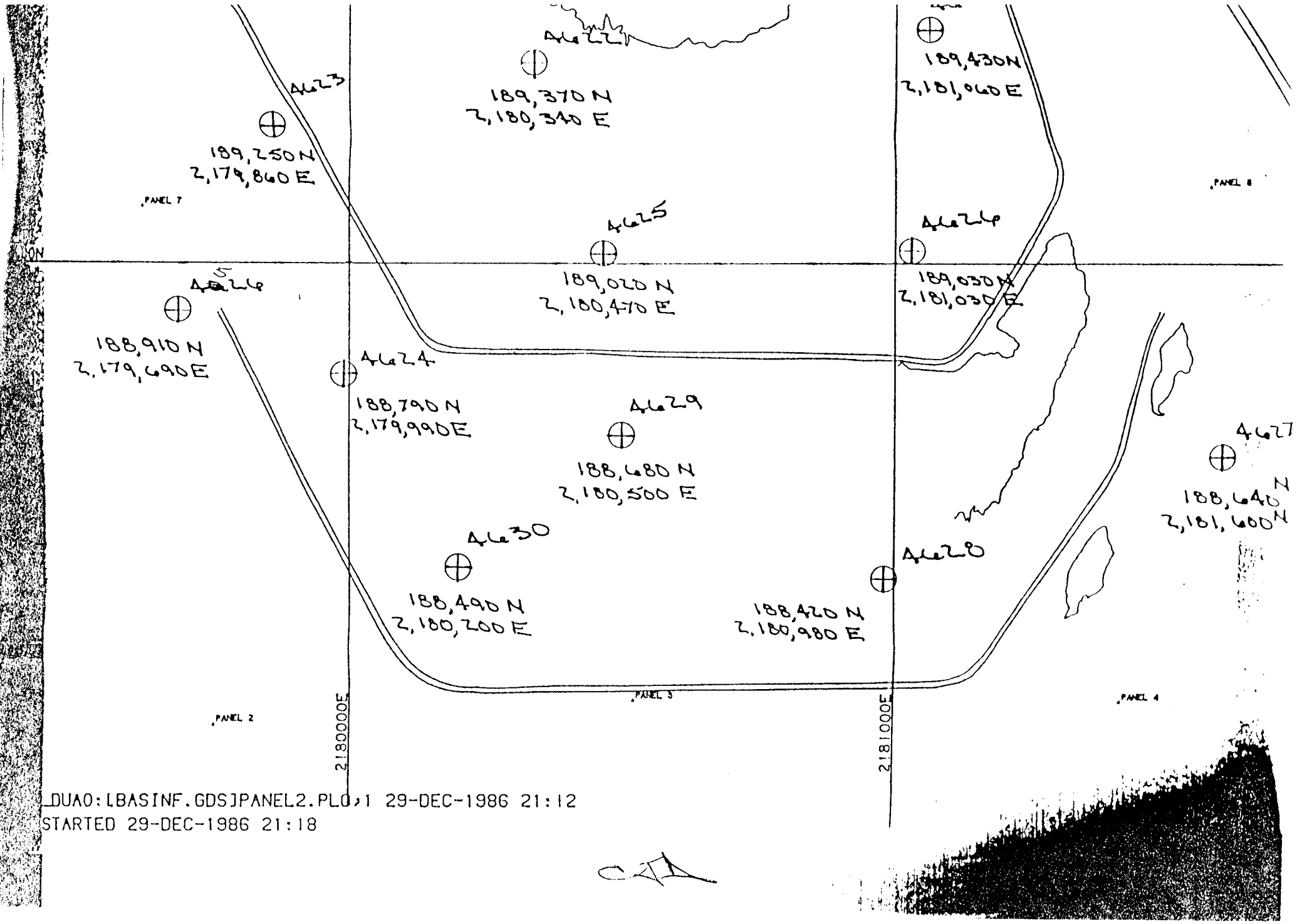
5411.2 x 27 = 146,102.4 *

* 146,102.4 x 7.482 = 1,093,138.2 Gal.

X sect., Act = 1" = 10'

Fluid = 2,186,300 gal.


00:01:13 <17 METRES OF LINE 3598 LINES OF PLOTCODE.
4534
PANEL 16
PANEL 17
PANEL 12
PANEL 18
2180000E
2181000E
190,070N
2,179,690E
4Le17
190,500N
2,180,040E
4Le18
190,130N
2,179,460E
4Le19
190,070N
2,180,900E
4Le20
189,770N
2,180,990E
4Le22
189,370N
2,180,340E
4Le23
4Le21
189,430N
2,181,060E
Borings From
Figure 26-4-1
Contamination
Assessment Report
October 1986



DUA0:[BASINF.GDS]PANEL2.PLO;1 29-DEC-1986 21:12
STARTED 29-DEC-1986 21:18

10 mg
2 mg

Chk by RWG

Project Basin "F" | Computed C. T. Dreeland

Subject Lagoons | Date 3/87 | Sht. | Of

1) 2 M Gallons (e Waste Disp)
Depth = 5 Ft. (2 Ft. Freeboard above 5 Ft., berm)
Slopes = 4:1

$V = h/3 (A_1 + A_2 + \sqrt{A_1 A_2})$

$A_1 = x^2$

$A_2 = (x + 4(5)2)(x + 4(5)2) = (x+40)(x+40) = x^2 + 80x + 1,600$

$V = h/3 (x^2 + x^2 + 80x + 1,600 + \sqrt{x^2 [x^2 + 80x + 1,600)}$

try $x = 250'$ (bottom)

$V = 5/3 [250^2 + 250^2 + 80(250) + 1,600 + \sqrt{250^2 [250^2 + 80(250) + 1,6}$
$= 345,167$ C.F. $= 2,708,000$ gal. OK

try $x = 225'$

$V = 5/3 [2(225)^2 + 80(225) + 1,600 + \sqrt{225^2 [225^2 + 80(225) + 1,600]}$
$= 300,190$ C.F. $= 2,250,200$ gal ← use

2) 10 M Gallons (Normal)
Depth = 5 Ft. (2 Ft. Freeboard above 5 Ft., berm)
Slopes = 4:1

try $x = 350'$ (bottom)

$V = 5/3 [2(350)^2 + 80(350) + 1,600 + \sqrt{350^2 [350^2 + 80(350) + 1,600]}$
$= 685,170$ C.F. $= 5,125,730$ gal

try $x = 500'$

$V = 5/3 [2(500)^2 + 80(500) + 1,600 + \sqrt{500^2 [500^2 + 80(500) + 1,600]}$
$= 1,352,670$ C.F. $= 10,119,300$ gal ← use

chkd by RWB

Project Basin 'F' | Computed

Subject Liquid Drainage | Date 1/87 | Sht. | Of

1) Hygroscopic (Bound) Water Content

2) Saturated Water Content

3) Gravitational Water (Saturated - Bound)

4) Darcy's

$Q = k \cdot i \cdot A \Rightarrow Q_{vol.} = k \cdot i \cdot A \cdot t$

$k = 100 D_{10}^2$ Hazen's approximation

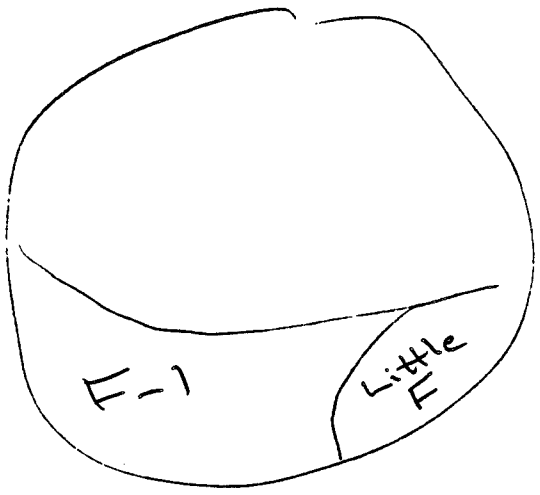
D_{10} = effective size in centimeters

5) Soils - CL, CH, ML & SM (Below Liner)

D_{10} = 0.01 mm - 0.0008 mm

6) Overburden Soils - sands w/ salt precipitations, wind blown soil & dumped solid wastes

1 Ft. sand + 0.34 Ft. etc.



7) 12/85 Closure Plan estimates 240,000 C.Y. overburden (93A. x 1.6 Ft. depth)

$\bar{x}$ = 21.20 Ft/16 borings = 1.33 Ft. ave.

Chk by RWB

Project	Basin F	Computed	CJT
Subject	Additional Fluid	Date	12/3/96

Mean Annual Precipitation

20 in./yr. Ave.

Volume

Area = 92 A.

Volume = 92 (43,560) (20/12) (7.481) = 49,967,095 gal.

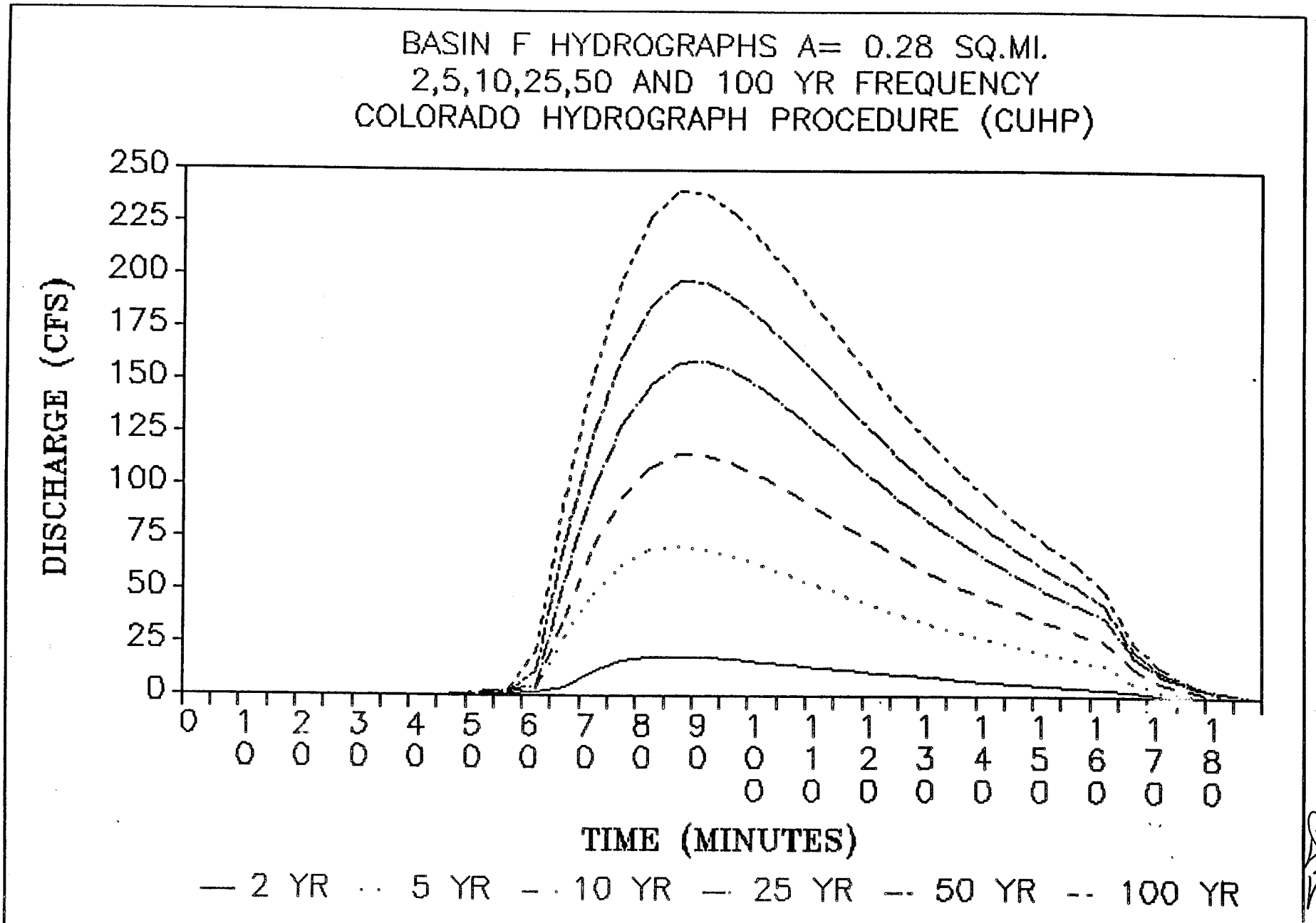
chk by EWG

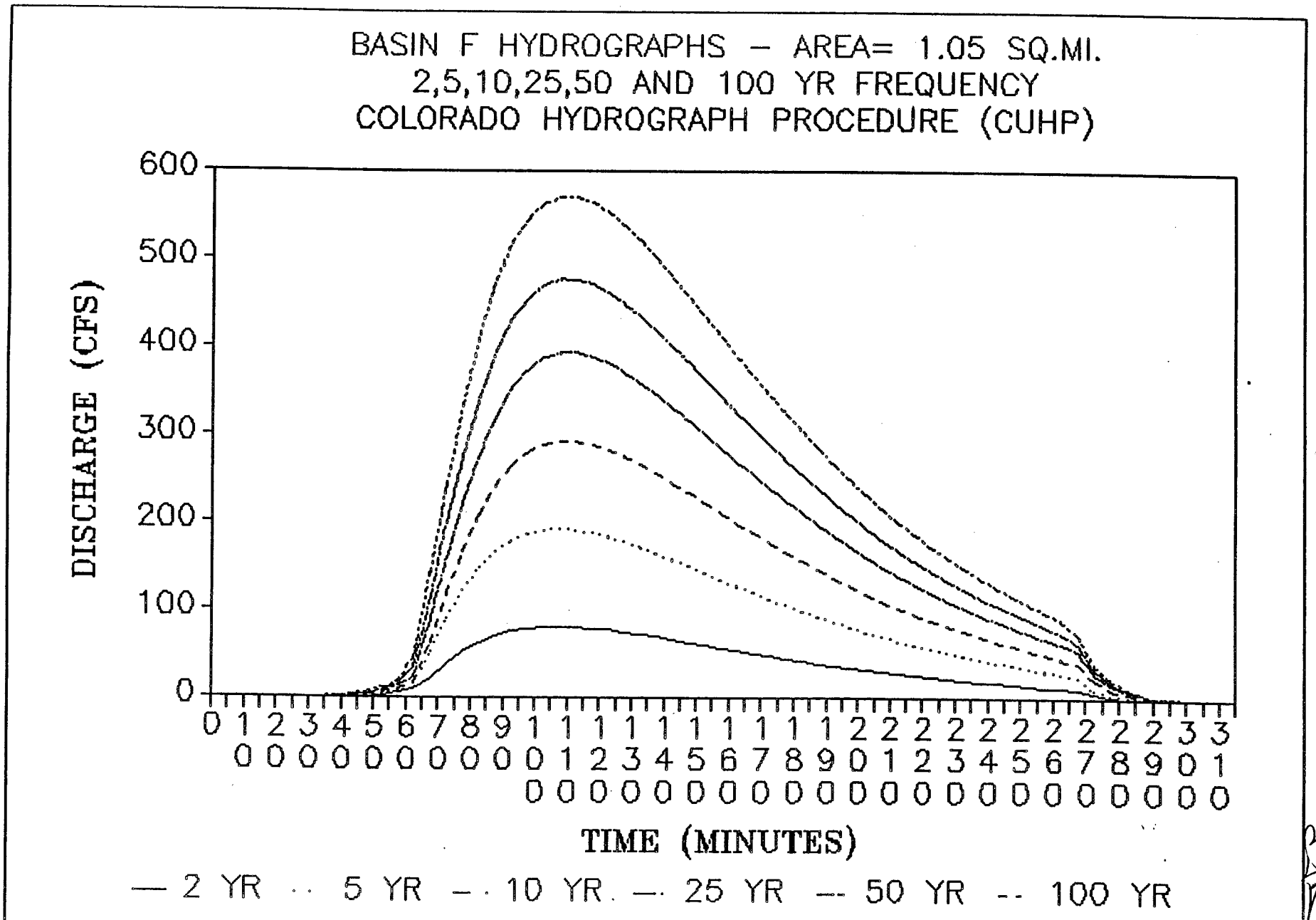
Project | Computed

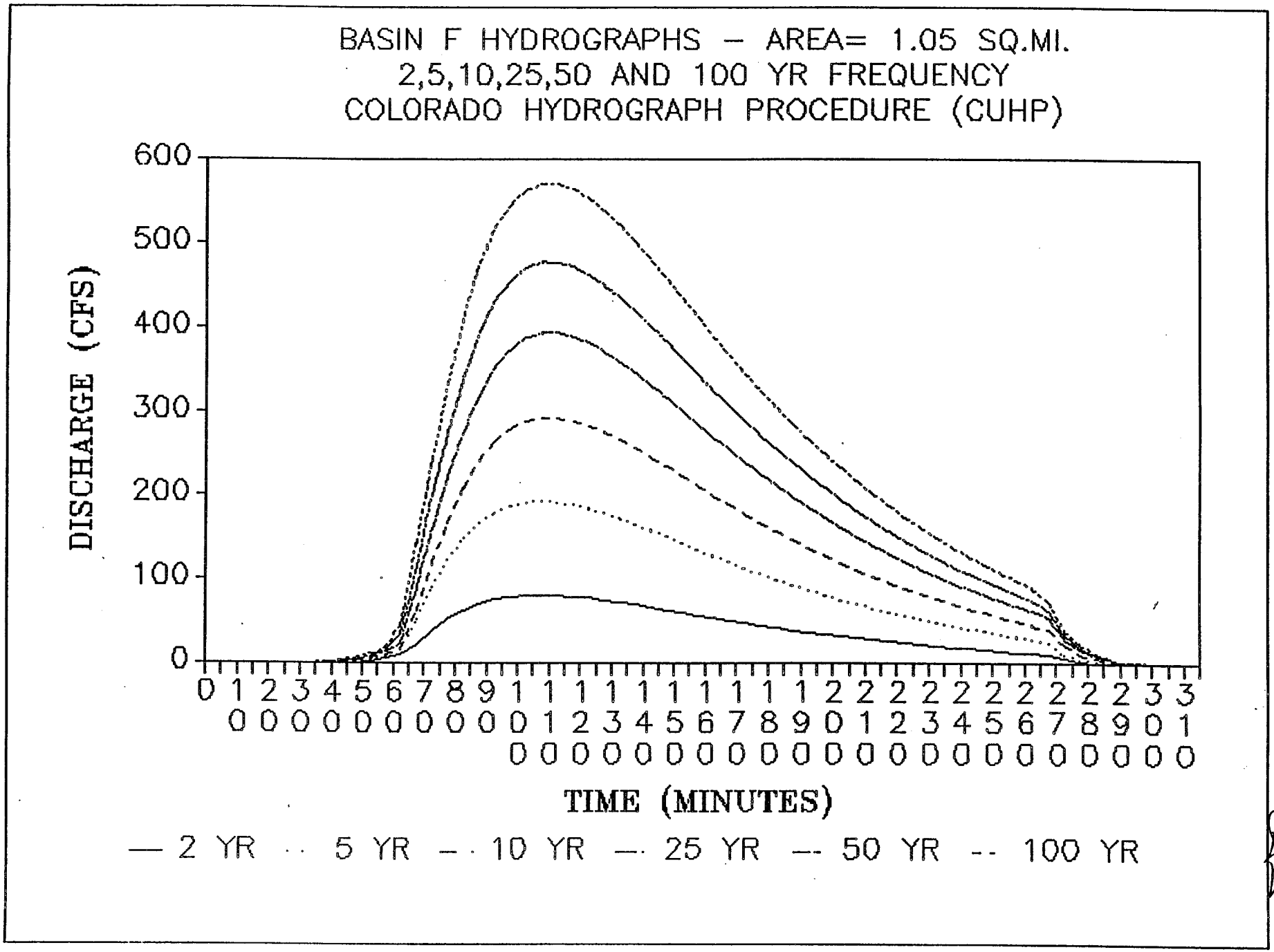
Subject | Date 12/96 | Sht. | Of

Hydrology

-soils- medium grained sand (1'-15' depth)
underlain w/ clayey-sandy-silt (20' depth)
underlain by course sand/gravel


BASIN F HYDROGRAPHS A= 0.28 SQ.MI.
2,5,10,25,50 AND 100 YR FREQUENCY
COLORADO HYDROGRAPH PROCEDURE (CUHP)
DISCHARGE (CFS)
250
225
200
175
150
125
100
75
50
25
0
0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800
TIME (MINUTES)
— 2 YR · · 5 YR - · 10 YR — 25 YR -- 50 YR -- 100 YR


BASIN F HYDROGRAPHS – AREA= 1.05 SQ.MI.
2,5,10,25,50 AND 100 YR FREQUENCY
COLORADO HYDROGRAPH PROCEDURE (CUHP)
DISCHARGE (CFS)
600
500
400
300
200
100
0
0 1 2 3 4 5 6 7 8 9 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
0 0 0 0 0 0 0 0 0 0 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
TIME (MINUTES)
— 2 YR · · 5 YR – · 10 YR — · 25 YR — — 50 YR - - 100 YR


BASIN F HYDROGRAPHS – AREA= 1.05 SQ.MI.
2,5,10,25,50 AND 100 YR FREQUENCY
COLORADO HYDROGRAPH PROCEDURE (CUHP)
DISCHARGE (CFS)
600
500
400
300
200
100
0
0 1 2 3 4 5 6 7 8 9 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
0 0 0 0 0 0 0 0 0 0 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
TIME (MINUTES)
— 2 YR · · 5 YR – · 10 YR — · 25 YR – – 50 YR · · 100 YR

RATIONAL EQUATION FOR BASIN F - RMA AREA IN AC 93.47

DURATION (HR)	FREQUENCY (YR)	RAINFALL (IN)	VOLUME GALLONS
1	2	0.96	2,436,417
	5	1.35	3,426,212
	10	1.56	3,959,178
	50	2.23	5,659,595
	100	2.60	6,598,631
6	2	1.44	3,654,626
	5	1.97	4,999,732
	10	2.30	5,837,250
	50	3.13	7,943,736
	100	3.53	8,958,910
24	2	2.00	5,075,870
	5	2.70	6,852,424
	10	3.10	7,867,598
	50	4.30	10,913,120
	100	4.80	12,182,087

BASIN F RMA
HYDROGRAPH SUMMARY

NORTHERN BASIN A=0.28 SQ. MI.

	TIME TO PK (MIN)	DISCHARGE (CFS)
2 YR	85.00	18.66
5 YR	85.00	70.92
10 YR	85.00	115.27
25 YR	90.00	159.66
50 YR	85.00	197.73
100 YR	85.00	240.52

ENTIRE BASIN A=1.05 SQ. MI.

	TIME TO PK (MIN)	DISCHARGE (CFS)
2 YR	105.00	80.99
5 YR	105.00	191.95
10 YR	105.00	292.43
25 YR	110.00	393.41
50 YR	105.00	477.51
100 YR	105.00	570.65

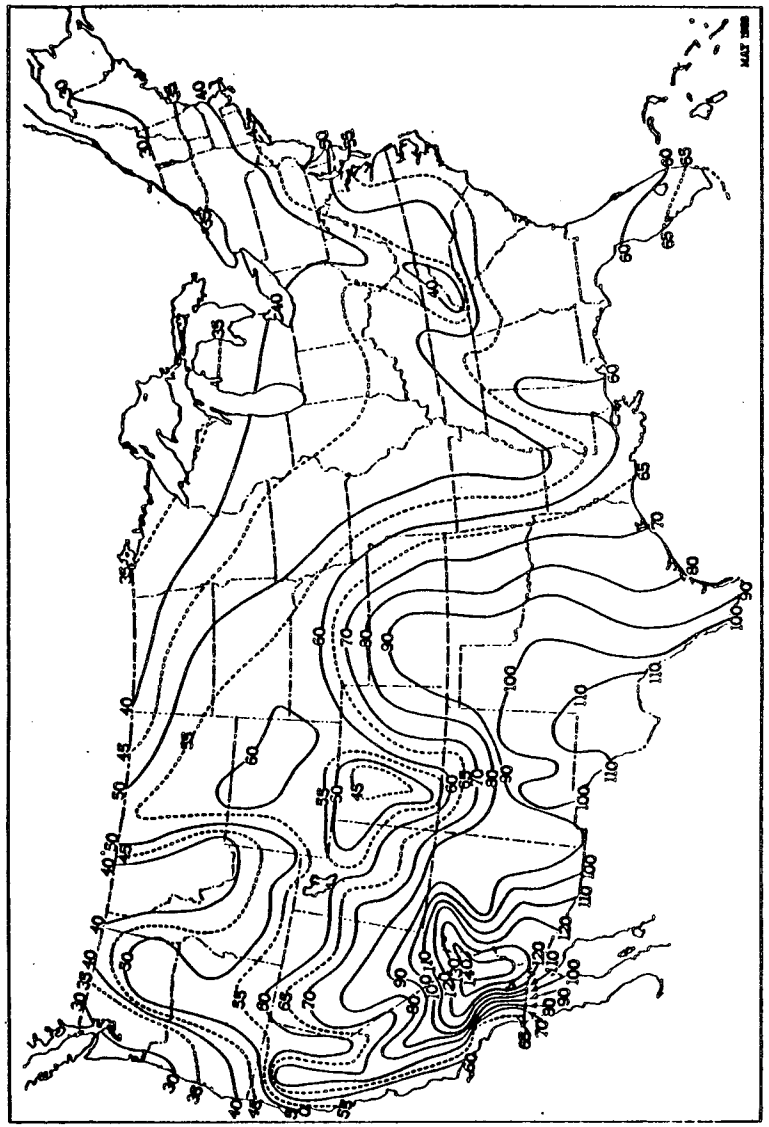


FIG. 5-7. Normal annual Class A pan evaporation in inches. (U.S. Weather Bureau.)

TRANSPIRATION

Only minute portions of the water absorbed by the root systems of plants remain in the plant tissues; virtually all is discharged to the atmosphere as vapor through the process known as *transpiration.* This process constitutes an important phase of the hydrologic cycle since it is the principal mechanism by which the precipitation falling on land areas is returned to the atmosphere. In studying the water balance of a drainage basin, it is usually found impracticable to separate evaporation and transpiration, and the practicing engineer therefore treats the two factors as a single item. Nevertheless, a knowledge of each process is required to assure that the techniques employed are consistent with physical reality.

5-8. Factors affecting transpiration. The meteorological factors which influence evaporation are also active in the transpiration process. The importance of solar radiation is amplified since the rate of movement of water within the plant depends upon sunlight; transpiration and plant growth are both closely related to radiation received. Thus while 75 to 90 per cent of daily soil evaporation occurs between sunrise and sunset,[1] about 95 per cent of the daily transpiration occurs during the daylight hours.[2] Optimum temperature and radiation for maximum growth vary with plant species, but all activity virtually ceases when the temperature drops to near 40°F.

Transpiration is limited by the rate at which moisture becomes available to the plants. Although there is little doubt that the rate of soil evaporation, under fixed meteorological conditions, decreases quasi-exponentially with time, divergent views persist with respect to transpiration.[3] It is believed that the controversy and apparent discrepancies can be attributed to the varied methods of deriving supporting data and the nondescript terminology used to describe the results. Some investigators believe that transpiration is independent of available moisture until it has receded to the *wilting point* (moisture content at which permanent wilting of plants occurs) while others assume that transpiration is roughly proportional to the moisture remaining in the soil and available to the plants. The *field capacity* is defined as the amount of water held in the soil after excess gravitational water has drained, and the range in soil moisture from field capacity to wilting point (*available water*) is a measure of the maximum quantity of water available for

[1] H. Landsberg, "Physical Climatology," p. 136, Pennsylvania State University, University Park, Pa., 1941.

[2] C. H. Lee, Transpiration and Total Evaporation, Chap. VIII, p. 280, in O. E. Meinzer (ed.), "Hydrology," McGraw-Hill, New York, 1942.

[3] F. J. Veihmeyer and A. H. Hendrickson, Does Transpiration Decrease as the Soil Moisture Decreases, *Trans. Am. Geophys. Union*, Vol. 36, pp. 425–448, June, 1955.

ıe cutting edge on the leading section is designed to penetrate ice yers when the tube is rotated. When the bottom of the snow pack reached, the snow depth is determined from the graduations on the be. The tube and its contents are then withdrawn and weighed to termine the water equivalent. For convenience most tubes have a ameter such that 1 oz is equivalent to 1 in. of water.

Because of the highly variable snow pack resulting from drifting and nuniform melting, 3 to 10 measurements are made at intervals of 10 50 ft along an established line, or *snow course*. Courses are selected sites free from extensive wind effects and lateral drainage of melt ıter. Even then the measurement for each course is considered to be ly an index to areal snow pack. Monthly or semimonthly snow sur-ys are made in late winter and early spring at over 1000 courses in the estern mountain region by the U.S. Soil Conservation Service and operating agencies. The U.S. Geological Survey and cooperators ake similar surveys at over 500 courses in the Northeastern states. wice-weekly observations of water equivalent are made at all first-der U.S. Weather Bureau stations, but these data are not published a current basis.

Snow is usually composed of ice crystals and liquid water; the amount liquid water is referred to as the *water content* of the snow. The *ality of snow*, i.e., the percentage by weight which is ice, can be deter-ined by a calorimetric process.[1] Snow is inserted into a thermos bottle ntaining hot water. The quality can be computed from initial and ıal temperatures and weights (or volumes) of the water and melted ow. The water content in per cent of the water equivalent is 100 inus the quality. Most evaluations of quality made to date indicate lues of 90 per cent or more, but values as low as 50 per cent have been tained at times of rapid melting.

3-14. Variations. The mean annual snowfall for the United States shown in the map (Fig. 3-10). This map may be considerably in ror in mountainous regions because of the paucity of measurements at gh elevations. As should be expected, there is a gradual increase of owfall with latitude and elevation. In the Sierra Nevada and Cascade ange annual snowfalls of 400 in. are not uncommon. In general, aximum annual snowfall occurs at slightly higher elevations than aximum annual precipitation.

Maps of mean depth of snow on the ground or mean water equivalent r specific dates are not available. Snow depths would, of course, be uch lower than annual snowfall amounts because of compaction of old

[1] M. Bernard and W. T. Wilson, A New Technique for the Determination of the eat Necessary to Melt Snow, *Trans. Am. Geophys. Union*, Vol. 22, Part 1, pp. 178-1, 1941.

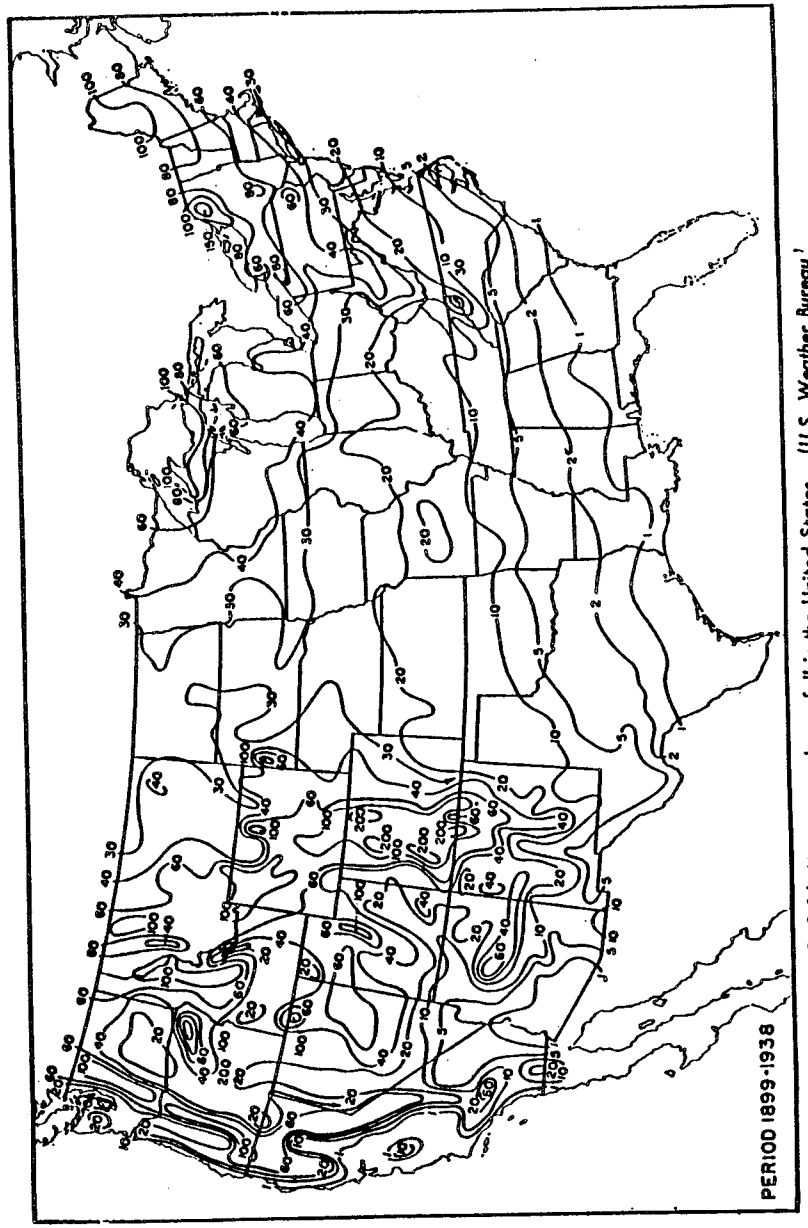


FIG. 3-16. Mean annual snowfall in the United States. (U.S. Weather Bureau)

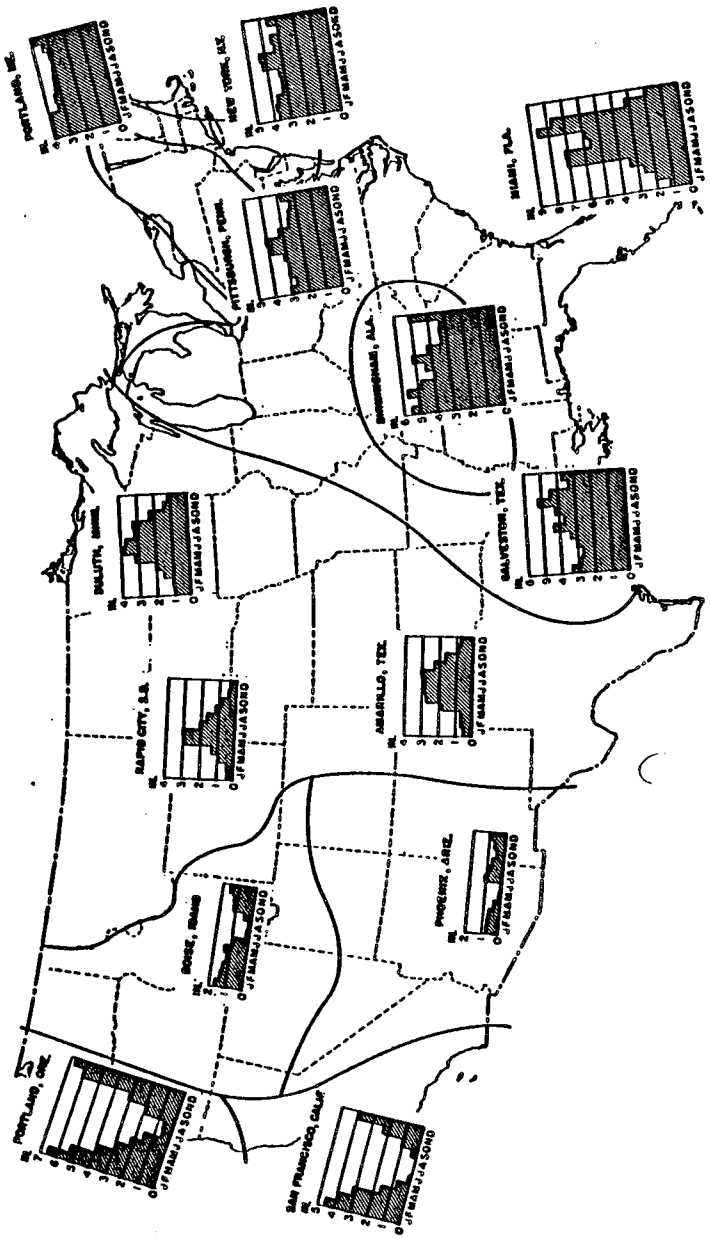


FIG. 3-14. Typical monthly distribution of precipitation in various climatic regions.

3-11. Time variations. While portions of a precipitation record may suggest an increasing or decreasing trend, there is usually a tendency to return to the mean; abnormally wet periods tend to be balanced by dry periods. The regularity of these fluctuations has been repeatedly investigated. More than 100 apparent cycles, ranging in period from 1 to 744 yr, have been reported.[1] The bibliography lists several reports on attempts to detect these variations from the analysis of tree rings and geological formations or to associate them with fluctuations in sunspots

TABLE 3-2. Maximum Recorded Rainfalls at Five Major U.S. Cities
(After Shands and Ammerman)

Station	Duration					
	Minutes			Hours		
	5	15	30	1	6	24
New York, N.Y.	0.75 8/12/26	1.63 7/10/05	2.34 8/12/26	2.97 8/26/47	4.09 10/9/03	9.55 10/8/03
St. Louis, Mo.	0.60 7/9/42	1.39 8/8/23	2.56 8/8/23	3.47 7/23/33	3.72 7/23/33	8.78 8/15/46
New Orleans, La.	1.00 2/5/55	1.90 4/25/53	3.18 4/25/53	4.71 4/25/53	7.95 4/15/27	14.01 4/15/27
Denver, Colo.	0.91 7/14/12	1.54 7/14/12	1.72 7/14/12	2.20 8/23/21	2.91 8/23/21	6.53 5/21/76
San Francisco, Calif.	0.33 1/25/26	0.65 11/4/18	0.83 3/4/12	1.07 3/4/12	1.70 1/12/14	4.67 1/29/81

and solar radiation. However, with the exception of diurnal and seasonal variations, no persistent regular cycles of any appreciable magnitude have been conclusively demonstrated.[2]

The seasonal distribution of precipitation varies widely within the United States. Figure 3-14 shows typical seasonal distribution graphs for stations in the precipitation regions defined by Kendrew.[3]

3-12. Record rainfalls. Table 3-1 lists the world's greatest observed point rainfalls. The predominance of U.S. stations for durations under 24 hr should not be interpreted as a tendency for heavier short-duration rainfall in the United States. The large number of recording rain gages

[1] Sir Napier Shaw, "Manual of Meteorology," 2d ed., Vol. 2, pp. 320–325, Cambridge, London, 1942.

[2] H. Landsberg, Climatology, Sec. XII, in F. A. Berry, Jr., E. Bollay, and N. R. Beers (eds.), "Handbook of Meteorology," p. 964, McGraw-Hill, New York, 1945.

[3] W. G. Kendrew, "The Climate of the Continents," 4th ed., p. 434, Oxford, New York, 1953.

:ions over areas of various sizes. The method[1] discussed here is somewhat arbitrary but has been standardized by the Federal agencies so that results will be comparable. For a storm with a single major center, the isohyets are taken as boundaries of individual areas. The average storm precipitation within each isohyet is computed as described in Sec. 3-8. The storm total is distributed through successive increments of time (usually 6 hr) in accordance with the distribution recorded at nearby stations.[2] When this has been done for each isohyet, data are available showing the time distribution of average rainfall over areas of various sizes. From these data, the maximum rainfall for various durations (6, 12, 18 hr, etc.) can be selected for each size of area. These maxima are plotted (Fig. 3-11), and an enveloping depth-area curve is drawn for each duration. Storms with multiple centers are divided into zones for analysis.

VARIATIONS IN PRECIPITATION

3-10. Geographic variations. In general, precipitation is heaviest at the equator and decreases with increasing latitude. However, the irregularity and orientation of the isohyets on the mean annual precipitation map of the United States (Fig. 3-12) indicate that the geographic distribution of precipitation depends on more effective factors than distance from the equator. A study[3] of maximum rainstorms in the United States indicated heaviest intensities at about 30°N.

The main source of moisture for precipitation is evaporation from the surface of large bodies of water. Therefore, precipitation tends to be heavier near coastlines. This characteristic is shown by the isohyets of Fig. 3-12, especially northward of the Gulf of Mexico. Although distorted by orography, a similar variation is observed in the Far Western states.

Since lifting of air masses accounts for almost all precipitation, amounts and frequency are generally greater on the windward side of mountain barriers. Conversely, since downslope motion of air results in decreased relative humidity, the lee sides of barriers usually experience relatively light precipitation. However, the continued rise of air immediately

[1] Manual for Depth-Area-Duration Analysis of Storm Precipitation, *U.S. Weather Bur. Coop. Studies Tech. Paper* 1, 1946.

R. K. Linsley, M. A. Kohler, and J. L. H. Paulhus, "Applied Hydrology," pp. 79–90, McGraw-Hill, New York, 1949.

[2] A. L. Shands and G. N. Brancato, Applied Meteorology: Mass Curves of Rainfall, *U.S. Weather Bur. Hydrometeorol. Tech. Paper* 4, 1947.

[3] R. A. McCormick, Latitudinal Variation of Maximum Observed United States Rainfall East of the Rocky Mountains, *Trans. Am. Geophys. Union*, Vol. 30, pp. 215–220, April, 1949.

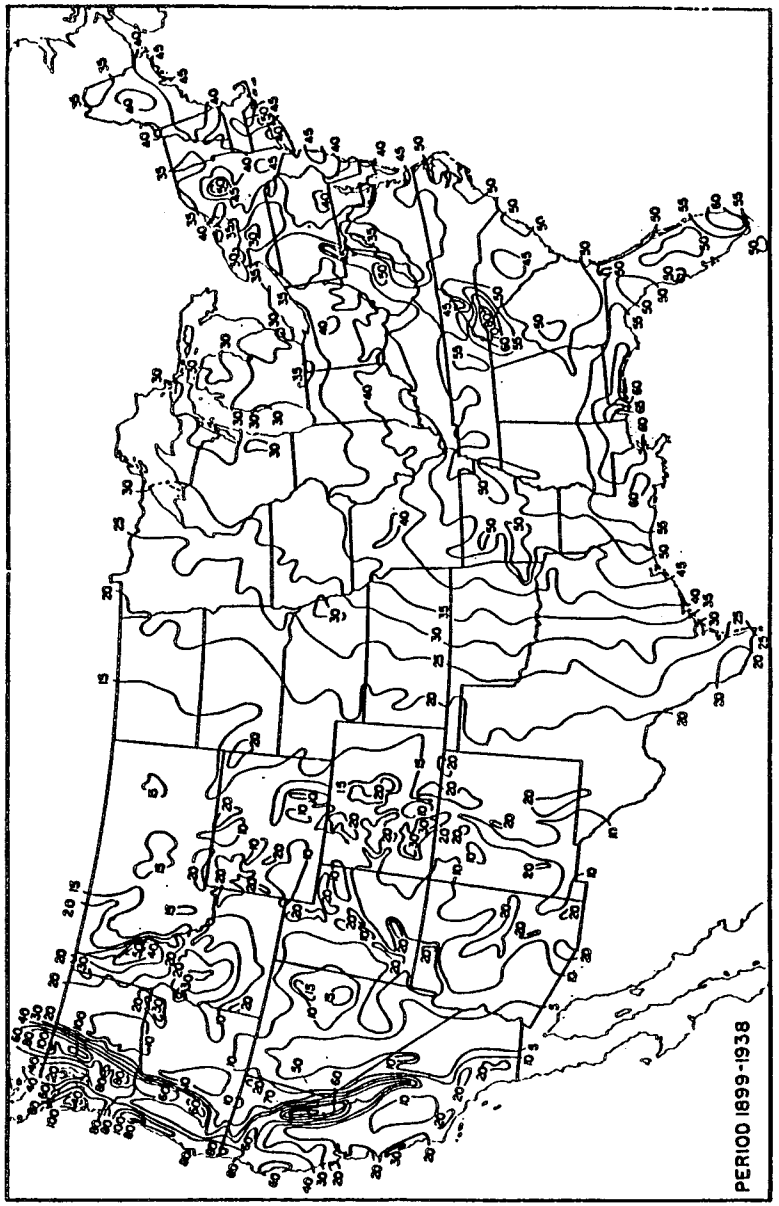


FIG. 3-12. Mean annual precipitation in the United States. (*U.S. Weather Bureau.*)

Chk by EwG

Project Basin F | Computed CTA

Subject Fluid Quantities | Date 1/5/87 | Sht. 1 | Of 1

North Pool

Area = 870,611 S.F.
Ave. Depth = 0.33 Ft. (based on info in 23 Oct 86 letter of Holme Roberts & Owen)
Vol. = (870,611)(0.33)(7.481) = 2,149,303 gal.

Southwest Pool

Area = 116,510 - 193 = 116,317 S.F.
Ave. Depth = 0.23 Ft. (based on 23 Oct 86 letter)
Vol. = 116,317 (0.23)(7.481) = 200,139 gal.

Southeast Pool

Area = 139,741 S.F.
Ave. Depth = 0.45 Ft. (based on 23 Oct 86 letter)
Vol. = 139,741 (0.43)(7.481) = 470,431 gal.

2 S.E. Pools

Area = 7,451 + 5,814 = 13,265 S.F.
Ave. Depth = 0.1 Ft. (assumed)
Vol. = 13,265 (0.1)(7.481) = 9,923 gal.

Total Vol. = 2,829,796 gal. as of 10/25/86

Chk by RWG

Project RMA-Basin F-WWC | Computed CTL

Subject 4000-02-34 | Date 1/3/87 | Sht. 1 | Of

Solids Removal - Overexcavation

- Sprayed asphalt liner w/ 1 ft. soil cover (1956)
- Rip-rap along shores? (April 1957)
- Dike along south end; Basin F-1 (1964)
- Erosion of south & east sides (1966)
  (Extensive cracking of liner on east side running parallel to shore for nearly 100 ft)
- Contaminated soils below Basin F estimated at 1,360,000 c
- Overburden soils extremely soft & nearly saturated
- Boreholes 4621, 4622 & 4623 contained no concentrations
- Deepest contamination along east boundary of main basin F and in pond F-1 (southernmost area of Basin F
- → Ned Figure 2e-6a-6 (pg. 25)
- Liner integrity questionable at boreholes 4620, 4626, 4627 & 46
- Soil beneath liner & uncertain integrity at boreholes 4619, 4620, 4621 & 4623 < 5 ft. depth.
- Fluid contains 16% solids by weight

Borehole No.	Coord. Elev.	Overburden Thk. (ft.)	Discoloration	Depth Target Analyte
4617	5189.3	1.5	—	1 ft.
4618	5189.0	1.0	—	1 ft.
4619	5190.3	1.5	—	—
4620	5189.4	2	Yes	20 ft ?
4621	5190.8	1.5	—	—
4622	5188.5	1.5	Yes, 1 in.	? metals
4623	5192.8	1.3	Slight	? metals
4624	5193.8	1.2	Yes, 2.5 in.	? metals
4625	5190.0	1.7	Yes	? metals
4626	5190.8	1.3	Yes, 4 in.	5 ft.
4627	5197.0	1.0	Yes	1 ft.
4628	5193.7	1.5	—	? metals
4629	5193.0	1.5	?	? metals
4630	5194.3	0.25	—	5 ft.

CROSS SECTION VALUES

Cross Section Number	Left													Ce
	1,300'	1,200'	1,100'	1,000'	900'	800'	700'	600'	-500'	-400'	-300'	-200'	-100'	
1														
2														
3									410' —	5197.8	5193.7	5193.2	5192.4	5193.
4								460' —	450' 5192.5	5194.3	5193.0	5192.4	5191.9	5192.
5								515' —	460' = 5193.0 5196.8	5192.9	5192.5	5192.0	5191.8	5191.
6							560' —	550' 5197.0	5192.9	5192.3	5191.8	5191.8	5191.8	5191.
7							620' —	535' = 5193.0 5196.6	5192.6	5192.0	5191.5	5191.5	5191.2	5192. 5190.
8					675' —	660' 5196.0	620' 5193.0	5192.7	5191.5	5192.8 5190.8	5191.0	5192.8 5190.8	5192.8 5190.8	5191.
9						725' —	665' = 5193.0 5195.7	5193.0 5192.5	5192.5 5190.5	5191.1	5190.5	5190.2	5189.7	5190.
10					780' —	745' 5193.0	5192.2	5192.9 5190.9	5192.6 5190.6	5190.7	5189.7	5189.1	5188.3	5188.
11					825' —	5193.0	5192.3	5191.0	5191.5	5189.4	5188.5	5188.0	5187.9	5188
12				880' —	850' 5193.0	5192.0	5191.5	5192.5 5190.5	5190.4	5189.1	5188.5	5187.8	5186.8	5186.
13				930' —	5193.0	5191.6	5192.7 5190.7	5191.0	5188.0	5188.6	5188.4	5187.6	5186.6	5186.
14			980' —	920' 5192.0	5191.8	5191.2	5192.7 5190.7	5188.2	5187.9	5186.8	5187.0	5186.8	5185.8	5185.
15			1030' —	5192.5	5191.0	5192.6 5190.6	5190.3	5188.8	5188.0	5187.6	5187.0	5186.0	5187.6 5185.6	5187. 5185.
16		1080' —	1050' 5192.0	5191.0	5192.6 5190.6	5189.8	5188.7	5187.9	5187.1	5185.8	5187.6 5185.6	5187.5 5185.5	5187.5 5185.5	5187. 5185.
17		1080' = —	5192.0 5195.0	5192.7 5190.7	5189.0	5188.0	5186.8	5187.6 5185.6	5187.5 5185.5	5187.5 5185.5	5187.4 5185.4	5187.4 5185.4	5187.3 5185.3	5187. 5185.
18			1050' = —	5189.0 5187.5	5185.9	5185.7	5187.6 5185.6	5187.5 5185.5	5187.5 5185.5	5187.4 5185.4	5187.4 5185.4	5187.3 5185.3	5187.2 5185.2	5187. 5185.
19		1,120' —	1,075' = 5192.0	5188.0 5185.8	5185.7	5187.6 5185.6	5187.6 5185.6	5187.5 5185.5	5187.4 5185.4	5187.3 5185.3	5187.2 5185.2	5187.1 5185.1	5187.1 5185.1	5187. 5185.
20		1,125' —	5192.0	1,090' = 5188.0 5185.9	5185.8	5185.8	5185.8	5187.6 5185.6	5187.5 5185.5	5187.4 5185.4	5187.3 5185.3	5187.2 5185.2	5187.0 5185.0	5187. 5185.
21		1,130' —	1,070' = 5193.5	5187.0 5184.4	5186.0	5186.0	5186.0	5187.6 5185.6	5187.5 5185.3	5187.3 5185.3	5187.2 5185.2	5187.0 5185.0	5186.9 5184.9	5187. 5185.
22	1,125' —	1,100' 5193.0	1,070' 5188.7	5186.8	5185.9	5185.9	5185.8	5185.8	5187.6 5185.6	5187.3 5185.3	5187.1 5185.1	5186.9 5184.9	5186.7 5184.7	5186. 5184.
23	1,110' —	1,100' 5197.8	1,040' 5189.0	5186.8	5186.0	5185.9	5185.9	5185.8	5185.8	5187.6 5185.6	5187.0 5185.0	5186.7 5184.7	5186.5 5184.5	5186. 5181.
24				910' = —	5188.0 5187.7	5186.0	5186.0	5186.0	5185.9	5185.9	5185.8	5186.7 5184.7	5186.5 5184.5	5185. 5187.0
25			855' —	845' 5197.0	800' 5192.4	750' 5188.0	5186.9	5186.8	5186.9	5187.3	5187.2	5186.9	- 50 = 5186.6	5188. 5191.
26						685' —	675' 5197.0	5191.7	5191.0	5193.3	230' = 5196.0	—		
27														
28														

Chk'd by RWG

℄	Right															
—	100'	200'	300'	400'	500'	600'	700'	800'	900'	1,000'	1,100'	1,200'	1,300'	1,400'	1,500'	1,6
5193.2	5193.7	5193.8	5193.3	5193.0	5193.1	5194.2	5195.0	5194.3	5198.5	5200.1	5199.8	—				3
5192.0	5192.7	5192.8	5192.8	5192.6	5192.8	5192.0	5194.2	5194.7	5194.7	5197.1	5199.1	—				4
5191.9	5192.1	5191.9	5191.8	5191.4	5191.3	5191.3	5192.0	5194.1	5191.7	5193.8	5197.0	—				5
5191.7	5191.6	5191.5	5191.1	5192.8 5190.8	5192.8 5190.8	5192.5 5190.5	5192.0 5190.8	5194.8	5191.4	5190.5	5190.7	5198.8	1220' —			6
5192.8 5190.8	5191.1	5191.1	5192.8 5190.8	5192.6 5190.6	5192.3 5190.5	5192.0 5190.0	5192.3 5190.3	5194.8	5190.8	5189.9	5189.9	5198.2	1220' —			7
5191.0	5191.1	5191.1	5191.1	5192.8 5190.8	5192.8 5190.8	5191.1	5192.7 5190.7	5194.8	5190.7	5196.6 5189.6	5190.0	5198.5	1220' —			8
5193.0	5190.6	5190.9	5190.4	5187.8	5187.1	5187.8	5192.8 5190.8	5194.4 5194.8	5191.3	5192.1	5193.0	1160' 5198.2	1180' —			9
5188.7	5189.0	5190.0	5189.4	5187.1	5183.9	5184.1	5187.5	5192.8 5190.8	5195.3	5197.2	5198.1	1120' —				10
5193.2	5187.8	5188.2	5188.5	5186.5	5183.6	5183.6	5184.0	5189.8	5195.5	1,080' = 5197.5	5197.5 —					11
5186.8	5187.2	5187.7	5187.9	5186.2	5183.5	5183.6	5184.0	5190.0	5196.0	5197.5	1,040' —					12
5186.3	5186.6	5187.1	5187.1	5185.7	5183.1	5183.8	5185.4	5190.7	5195.9	5197.4	1,020' —					13
5185.7	5185.7	5185.8	5186.3	5185.0	5183.3	5185.1	5188.9	5194.1	5195.6	—						14
5187.5 5185.5	5187.5 5185.5	5187.5 5185.5	5187.6 5185.6	5184.5	5182.8	5185.5	5190.6	5194.0	—							15
5187.4 5185.4	5187.5 5185.5	5187.5 5185.5	5187.6 5185.6	5183.9	5182.0	5184.5	750' = 5192.0	5197.0 —								16
5187.3 5185.3	5187.4 5185.4	5187.5 5185.5	5187.6 5185.6	5184.8	5181.8	5186.8	5196.3	765' —								17
5187.3 5185.3	5187.4 5185.4	5187.5 5185.5	5187.6 5185.6	5183.8	5181.7	5191.0	—									18
5187.2 5185.2	5187.3 5185.3	5187.5 5185.5	5187.6 5185.6	5181.6	5185.6	5193.7	650' —									19
5187.2 5185.2	5187.3 5185.3	5187.5 5185.5	5187.6 5181.5	5186.3	550' = 5191.3	5195.8 —										20
5187.0 5185.0	5187.2 5185.2	5187.3 5181.4	5187.6 5185.6	5186.5	5193.8	650' —										21
5186.9 5184.9	5187.2 5181.3	5187.3 5185.3	5187.6 5185.6	5189.4	360' 5185.5	465' —										22
5186.5 5181.2	5187.0 5185.0	5187.5 5185.5	280' = 5188.5	5185.7 360' =	380' = 5196.0	—										23
5185.0 5187.0	60' 5185.7	100' 5189.0	130' 5186.2	200' 5192.5	250' —											24
5188.0 5191.0	75' —															25
																26
																27
																28

Note:
Self-Draining w/ Sump
At X∅∅24 ℄

Cross Section Values

Cross Section Number	Left													℄
	-1,300'	-1,200'	-1,100'	-1,000'	-900'	-800'	-700'	-600'	-500'	-400'	-300'	-200'	-100'	0
1														
2														
3									410' —	5197.8	5193.7	5193.2	5192.9	5193.2
4								460' —	450' 5192.5	5194.3	5193.0	5192.4	5191.9	5192.0
5								515' —	460'= 5196.8	5193.0 5192.5	5192.9	5192.0	5191.8	5191.9
6							560' —	550' 5197.0	5192.9	5192.3	5191.8	5191.8	5191.8	5191.7
7							620' —	535'= 5196.2	5193.0 5192.6	5192.0	5191.5	5191.5	5191.2	5192.8 5190.8
8					675' —	660' 5196.0	620' 5193.0	5192.7	5191.5	5192.8 5190.8	5191.0	5192.8 5190.8	5192.8 5190.8	5191.0
9						725' —	665'= 5195.7	5193.0 5192.5	5192.5 5190.5	5191.1	5190.5	5190.2	5189.7	5190.0
10					780' —	745' 5193.0	5192.2	5192.9 5190.9	5192.6 5190.6	5190.7	5189.7	5189.1	5188.3	5188.7
11					825' —	5193.0	5192.3	5191.0	5191.5	5189.4	5188.5	5188.0	5187.9	5188.7
12				880' —	850' 5193.0	5192.0	5191.5	5192.5 5190.5	5190.4	5189.1	5188.5	5187.8	5186.8	5186.8
13				930' —	5193.0	5191.6	5192.7 5190.7	5191.0	5188.0	5188.6	5188.4	5187.6	5186.6	5186.3
14			980' —	920' 5192.0	5191.8	5191.2	5192.7 5190.7	5188.2	5187.9	5186.8	5187.0	5186.8	5185.8	5185.7
15			930' —	5192.5	5191.0	5192.6 5190.6	5190.3	5188.8	5188.0	5187.6	5187.0	5186.0	5187.6 5185.6	5187.5 5185.5
16		1080' —	1050' 5192.0	5191.0	5192.6 5190.6	5189.8	5188.7	5187.9	5187.1	5185.8	5187.6 5185.6	5187.5 5185.5	5187.5 5185.5	5187.4 5185.4
17		1080'= —	5192.0 5195.0	5192.7 5190.7	5189.0	5188.0	5186.8	5187.6 5185.6	5187.5 5185.5	5187.5 5185.5	5187.4 5185.4	5187.4 5185.4	5187.3 5185.3	5187.3 5185.3
18			1050'= —	5189.0 5187.5	5185.9	5185.7	5187.6 5185.6	5187.5 5185.5	5187.5 5185.5	5187.4 5185.4	5187.4 5185.4	5187.3 5185.3	5187.2 5185.2	5187.3 5185.3
19		1,120' —	1,075'= 5192.0	5188.0 5185.8	5185.7	5187.6 5185.6	5187.6 5185.6	5187.5 5185.5	5187.4 5185.4	5187.3 5185.3	5187.2 5185.2	5187.1 5185.1	5187.1 5185.1	5187.2 5185.2
20		1,125' —	5192.0	1,080'= 5188.0 5185.8	5185.8	5185.8	5185.8	5187.6 5185.6	5187.5 5185.5	5187.4 5185.4	5187.3 5185.3	5187.2 5185.2	5187.0 5185.0	5187.2 5185.2
21		1,130' —	1,070'= 5193.5	5187.0 5184.4	5186.0	5186.0	5186.0	5187.6 5185.6	5187.5 5185.3	5187.3 5185.3	5187.2 5185.2	5187.0 5185.0	5186.9 5184.9	5187.0 5185.0
22	1,125' —	1,100' 5193.0	1,070' 5188.7	5186.8	5185.9	5185.9	5185.8	5185.8	5187.6 5185.6	5187.3 5185.3	5187.1 5185.1	5186.9 5184.9	5186.7 5184.7	5186.9 5184.9
23	1,110' —	1,100' 5197.8	1,040' 5189.0	5186.8	5186.0	5185.9	5185.9	5185.8	5185.8	5187.6 5185.6	5187.0 5185.0	5186.7 5184.7	5186.5 5184.5	5186.5 5184.5
24				910'= —	5188.0 5187.7	5186.0	5186.0	5186.0	5185.9	5185.9	5185.8	5186.7 5184.7	5186.5 5184.5	5185.0 5183.0
25			855' —	845' 5197.0	800' 5192.4	750' 5188.0	5186.9	5186.8	5186.9	5187.3	5187.2	5186.9	-50 = 5186.8	5188.0 5191.0
26						685' —	675' 5197.0	5191.7	5191.0	5193.3	230'= 5196.0	—		
27														
28														

Cut by Bill

℄	Right															
0	100'	200'	300'	400'	500'	600'	700'	800'	900'	1,000'	1,100'	1,200'	1,300'	1,400'	1,500'	1,600
5193.2	5193.7	5193.8	5193.3	5193.0	5193.1	5194.2	5195.0	5193.3	5198.5	5200.1	5199.8	—				3
5192.0	5192.7	5192.8	5192.8	5192.6	5192.8	5192.0	5194.2	5191.7	5191.7	5197.1	5199.1	—				4
5191.9	5192.1	5191.9	5191.8	5191.4	5191.3	5191.3	5192.0	5192.1	5191.7	5193.8	5197.0	—				5
5191.7	5191.6	5191.5	5191.2	5192.8 5190.8	5192.8 5190.8	5192.5 5190.5	5192.8 5190.8	5191.3	5191.4	5190.5	5190.7	5198.8	1220' —			6
5192.8 5190.8	5191.1	5191.1	5192.8 5190.8	5192.6 5190.6	5192.3 5190.3	5192.0 5190.0	5192.3 5190.3	5191.7	5190.8	5189.9	5189.9	5198.2	1220' —			7
5191.0	5191.1	5191.1	5191.1	5192.8 5190.8	5192.8 5190.8	5191.1	5192.7 5190.7	5191.7	5190.7	5196.6 5189.6	5190.0	5198.5	1220' —			8
5190.0	5190.6	5190.9	5190.4	5187.8	5187.1	5187.8	5192.8 5190.8	5192.4 5190.4	5191.3	5192.1	5193.0	1160' 5198.1	1180' —			9
5188.7	5189.0	5190.0	5189.4	5187.1	5183.9	5184.1	5187.5	5192.8 5190.8	5195.3	5192.2	5198.1	1120' —				10
5188.2	5187.8	5188.2	5188.5	5186.5	5183.6	5183.6	5184.0	5189.8	5195.5	1,000' = 5197.5	5197.5 —					11
5186.8	5187.2	5187.7	5187.9	5186.2	5183.5	5183.6	5184.0	5190.0	5196.0	5197.5	1,040' —					12
5186.3	5186.6	5187.1	5187.1	5185.7	5183.1	5183.8	5185.4	5190.7	5195.9	5197.4	1,020' —					13
5185.7	5185.7	5185.8	5186.3	5185.0	5183.3	5185.1	5188.9	5194.1	5195.6	—						14
5187.5 5185.5	5187.5 5185.5	5187.5 5185.5	5187.6 5185.6	5184.5	5182.8	5185.5	5190.6	5196.0	—							15
5187.4 5185.4	5187.5 5185.5	5187.5 5185.5	5187.6 5185.6	5183.9	5182.0	5184.5	750' = 5192.0	5197.0 —								16
5187.3 5185.3	5187.4 5185.4	5187.5 5185.5	5187.6 5185.6	5184.8	5181.8	5186.8	5196.3	765' —								17
5187.3 5185.3	5187.4 5185.4	5187.5 5185.5	5187.6 5185.6	5183.8	5182.9	5191.0	—									18
5187.2 5185.2	5187.3 5185.3	5187.5 5185.5	5187.6 5185.6	5184.4	5185.6	5193.7	650' —									19
5187.2 5185.2	5187.3 5185.3	5187.5 5185.5	5187.6 5185.6	5186.3	550' = 5191.3	5195.8 —										20
5187.0 5185.0	5187.2 5185.2	5187.3 5185.3	5187.6 5185.6	5186.5	5193.8	650' —										21
5186.9 5184.9	5187.2 5185.2	5187.3 5185.3	5187.6 5185.6	5189.4	360' 5185.5	465' —										22
5186.5 5184.5	5187.0 5185.0	5187.5 5185.5	280' = 5188.5	5185.7 360' = 5196.0	380' = —											23
5185.0 5183.0	60' 5185.7	100' 5189.0	130' 5186.2	200' 5192.5	250' —											24
5188.0 5191.0	75' —															25
																26
																27
																28

Note:
Min. Cut, Does Not
Down To Jump

4/87

Chk by Rev

8. QUANTITIES

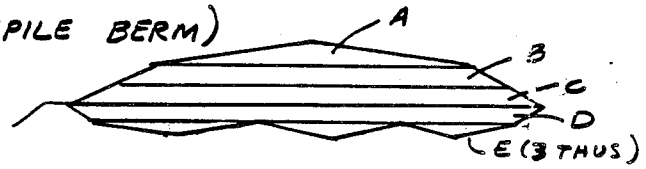
See attached 7 pages of computations for items excluding excavation and grading. Excavation and grading were computer generated.

Chk by RWG

Project BASIN F | Computed DMK

Subject QUANTITIES | Date 4-3-87 | Sht. 1 | Of 7

Hazardous Waste (WASTEPILE BERM)



A: $\frac{1}{3}(550 \times 500) \times \underset{(.06 \times 275)}{16.5} \div 27$ C.F./C.Y. = 56,018.52 - SAY 56,019 C.Y.

B. = $\frac{1}{3} \times \overset{(10'-.06)+14.5}{15.1'} \times \left[\underset{A_1}{(550 \times 500)}^{275,000} + \underset{A_2}{(672 \times 622)}^{417,984} + \sqrt{A_1 \times A_2} \right] \div 27 =$

= 192,388.97 - SAY 192,389 C.

C = $\frac{1}{3} \times \overset{(50' \times 1/4)}{12.5'} \times \left[\underset{A_1}{(686 \times 636)}^{436,296} + \underset{A_2}{(786 \times 736)}^{578,496} + \sqrt{A_1 \times A_2} \right] \div 27 =$

= 234,132.99 - SAY 234,133 C.

D = $\frac{1}{3} \times \overset{12.5-12.5}{5'} \times \left[\underset{A_1}{(786 \times 736)}^{578,496} + \underset{A_2}{(750 \times 700)}^{525,000} + \sqrt{A_1 \times A_2} \right] \div 27$

= 102,135.51 - SAY 102,136 C.Y.

E (3-THUS = $\frac{1}{3} \times \overset{450 \times .02}{9'} [250' \times 700] \div 27 \times 3$ THUS =

= 58,333.33 — SAY 58,333 C.Y.

TOTAL HAZARDOUS WASTE 643,010 C.Y.

Chk by EWG

Project BASIN F | Computed DMK

Subject QUANTITIES | Date 4-3-87 | Sht. 2 | Of 7

Protective Soil Layer (12") (WASTE PILE BERM)

bottom $\sqrt{125^2+(125\times.02)^2} = 125.025 \times 6 = 750.15$

$\sqrt{700^2+(700\times.02)^2} = 700.14$

$(750.15' \times 700.14') \times 1' \div 27 = 19,452$ C.Y.

bottom 4:1 $18' \times 1/4 = 4.5$ slope = 18.55'

$750' + 18' + 700' + 18'' = 1486 \times 2 = 2972$

$(18.55' \times 2972) \times 1' \div 27 = 2,042$ C.Y

TOTAL BOTTOM: 21,494 C.Y

CAP (2 Layers)

275' @ 6% = 275.49 ; 250' @ 6.6% = 250.54

58' @ 4:1 = 59.79 ; 10' @ 6% = 10.02

61' @ 4:1 = 62.88

AREAS

$1/2 \times 550' \times 250.54' \times 1' \times 2 \div 27 = 5104$ C.Y.

$1/2 \times 500' \times 275.49' \times 1' \times 2 \div 27 = 5102$ C.Y

$[(550 + 58)\times 2] + [(500 + 58)\times 2] \times 59.79' \times 1' \div 27 = 5164$ C.Y

$[(550 + 116 + 10)\times 2] + [(500 + 116 + 10)\times 2] \times 10.02' \times 1' \div 27 = 966$

$[(550 + 116 + 20 + 61)\times 2] + [(500 + 116 + 20 + 61)\times 2] \times 62.88 \times 1' \div 27 = 6726$ C.

FOR ONE LAYER 23,062 C.

x 2

FOR TWO LAYERS 46,124 C.

(BERM) PERIMETER

$5' \times \frac{15 + 55}{2} [805 + 805 + 755 + 755] \div 27 = 20,222.22$

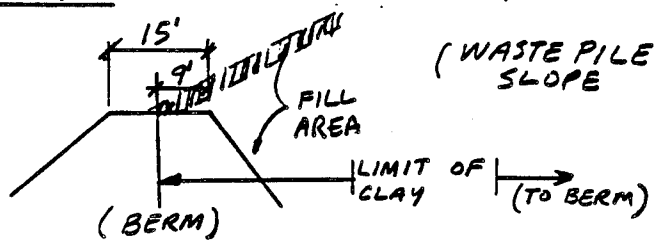
SAY 20,222 C.

PROTECTIVE SOIL TOTAL 87,840 C.Y

Chk by EWG

Project	BASIN F	Computed	DMK		
Subject	QUANTITIES	Date	4-3-87	Sht. 3	Of 7

clay (12") (See protective Soil Layer - cap per layer)



(WASTE PILE SLOPE) = 23,062 C.Y. ←

(PLANIMETERED)
102.51 S.I. FOR THE SITE = 151,866.67 C.Y.

151,866.67 C.Y. - (810' x 760' x 1') = 129,066.67 C.Y.
22,800 C.Y. (WASTEPILE PLAN)

plus (200 FT/IN x 3.9.7 IN) x (1' x 10') ÷ 27 = 2940.74 C.Y.
3'-3.7"

minus LEACHATE 238² x 1' ÷ 27 − 2097.93 C.Y.

CLAY (not including Leachate Lagoon & Wastepile Berm) → 129,909.48 − SAY 129,909 C.Y

SEE LEACHATE LAGOON CLAY QUAN.

TOP SOIL (6") (SEE clay quantity above ÷2)

WASTEPILE BERM = 11,531 C.Y. ←

(PLANIMETERED)
(127.60 S.I FOR THE SITE) − (LEACHATE LAGOON 204'²)

[(127.60 IN² x 200² S.F/IN²) − (204' ²)] x .5' ÷ 27 = 93,747.85 C.Y.
5,104,000 41616

93,747.85 C.Y. − (810' x 760' x .5 ÷ 27) = 82,348 C.Y.
(WASTEPILE BERM 11400)

93,879 C.Y

SEEDING

BASIN - see topsoil (PLANIMETERED) = (5,104,000 S.F. − 41616 LEACHATE − 612,464 (808 x 758) plan + 622,674 (23,062 x 27) WASTEPILE BERM slope) ÷ 9 = 563,622 S.Y.
5072.51 Y

NORTH LAGOON = 450' x 100' x 4 SIDES ÷ 9 = 20,000 S.Y.

FORCE MAIN = 150' x 1330' ÷ 9 = 22,167 S.Y.

TOTAL 605,789 SY.

÷ 4840 S.Y./AC. = 125.16 = 125.2 Ac.

Project BASIN F | Computed DMK | chk by RWG

Subject QUANTITIES | Date 4-3-87 | Sht. 4 | Of 7

60-MIL HDPE ; GEOTEXTILE ; GEONET (WASTEPILE BERM

(See 'Protective Soil LAYER')

bottom	750.15' x 700.14'	= 525,210 S.F.	= 58,357 S.Y.
"	(20.5' + 2' + 2') = 24.5' x 2972'	= 72,814 S.F.	= 8090 S.Y.
	PER LAYER	= 598,024 S.F.	66,447
cap.	½ x 550' x 250.54' x 2	= 137,797 S.F.	= 15,311 S.Y.
	½ x 500' x 275.49' x 2	= 137,745 S.F.	= 15,305 S.Y.
	2332 x 59.79'	= 139,430 S.F.	= 15,492 S.Y.
	2604 x 10.02	= 26,092 S.F.	= 2899 S.Y.
[(550+116+20+54) x 2] + [(500+116+20+54) x 2] (1480, 1380)	x 55.60 (52@4:1 + 2')	= 159,016 S.F.	= 17,668 S.Y.
	per layer	= 600,080 S.F.	= 66,675 S.Y.

GEONET (2 layers in Cap - 1 layer Bot.)

(600,080 x 2) + 598,024 = 1,798,184 S.F.

HDPE (1 layer in Cap - 1 layer Bot.)

600,080 + 598,024 = 1,198,104 S.F.

GEOTEXTILE (2 layers in Cap - 1 layer in Bot.)

(600,080 x 2) + 598,024 = 1,798,184 S.F.

Chk by BWG

Project BASIN F | Computed DMK

Subject QUANTITIES | Date 4-8-87 | Sht. 5 | Of 7

FENCE (Temporary Constr.)

4'-1.5" @ 200'/IN =

49.5" x 200'/in: 9900 LIN. FT

FENCE (EXISTING)

3'-4.9" @ 200'/IN.

40.9" x 200'/IN. 8180 LIN. FT.

Fence (WASTE PILE & NORTH LAGOON)

$(910' \times 2) + (960' \times 2) + (250' \times 2) =$ 4240 LIN. FT

1820 1920 500

Permanent Roadway (25 FT.)

14" x 200 FT/IN = 2800 L.F.

Chk by RWG

Project BASIN F	Computed DMK		
Subject QUANTITIES - LEACHATE LAGOON	Date 4-8-87	Sht. C9	Of 7

EXCAUATION Aug. 7' depth

$\frac{1}{3} \times 7' \left[140^2 + 161^2 + \sqrt{140^2 \times 161^2}\right] \div 27 = 5881.81$ C.Y.

$\frac{1}{3} \times 140' \times 140' \times .7' \div 27 = 169.38$ C.Y.

6051.19 — SAY 6051 C.Y.

BERM Aug. 3' high (1'0" clay included)

$\frac{10 + 22}{2} \times 2' \times 210 \times 4^{\text{SIDES}} \div 27 = 995.55$ — SAY 996 C.Y.

CLAY

$\left[\underset{19600}{(140)^2} + \left(\overset{10\times3\sqrt{30^2+10^2}}{31.62} \times 170 \times 4\right) + \underset{8400}{\left(10' \times 210' \times 4\right)} + \left(\overset{3\times3\sqrt{9^2+3^2}}{9.49} \times \underset{3692.84}{229'} \times 4\right)\right] \times 1' \div 27 =$

$58{,}194.44 \times 1' \div 27$ C.F./C.Y. $= 2155.35$ — SAY 2155 C.Y.

200 MIL GEONET

$\underset{19600}{(140)^2} + \left(\overset{10\times3\sqrt{30^2+10^2}}{31.62} \times 150' \times 4\right) = 38{,}572$ S.F.

$\div 9 = \underset{4285.78}{4286}$ S.Y.

60-MIL HDPE

(SEE 200 MIL GEONET QUAN)

38,572 S.F. x 2 LAYERS = 77,144 S.F.

$\div 9 = \underset{8571.56}{8572}$ S.Y.

Chk by EWC

Project BASIN F	Computed DMK		
Subject QUANTITIES - NORTH LAGOON	Date 4-8-87	Sht. 7	Of 7

EXCAVATION Avg. 9' depth

$\frac{1}{3} \times 9' \left[310^2 + 337^2 + \sqrt{310^2 \times 337^2}\right] \div 27 = 34,904.33$ C.Y.

$\frac{1}{3} \times 310 \times 310 \times 1.55' \div 27 =$ 1838.95 C.Y.

36,743.28 - SAY 36,743 C.Y.

BERM Avg. 3' high

$\frac{10' + 28'}{2} \times 3' \times 392' \times \overset{\text{SIDES}}{4} \div 27 =$ 3310.22 - SAY 3310 C.Y.

60-MIL HDPE

$(310)^2 + (37.95 \times 340 \times 4) =$ 147,712 S.F.

$\left(12' @ 3:1 \rightarrow \sqrt{36^2 + 12^2} = 37.95\right)$

$\div 9 =$ 16,412 S.Y.

16,412.44

4/87

9. MISCELLANEOUS DESIGN MATERIALS

Subject Summary of Decisions by COE

By D. Hawk Checked By

Date 4/5/87 Date

Project No. 86C8554P

Task No. 2

File No. 21947

Sheet 1 of 4

DECISIONS BY COE ON SPECS

✓ 1) SWITCH TO RFP

COE 2) Evaluation criteria must allow technically unqualified Contractors to fall out.

RFP 3) Contractors to submit schedules - we will provide milestone guidance.

summary of work

✓ 4) Express specs so that government can be assured of quality of product.

summary of work ✓ 5) Liquid removal is highest priority (September 1, 1987)

✓ 6) Ability to adapt Company SHERP quickly

✓ 7) Mobile pumping equipment

✓ 8) Award date July 22, 1987

✓ 9) Target cost of $6,000,000 for construction

✓ 10) Leave ~~of~~ construction staging to contractor

✓ 11) Specification: contractor must keep grading so that rain on clean areas is collected and not allowed to pond. It may be diverted offsite.

discharge directly

12) Contractor can provide "or equal" landfill design

a) Excavate minimum of 6-inches below asphalt

b) Compact foundation

c) 60 mil HDPE

d) 200 mil geogrid

e) geotextile

f) protective soil cover

✓ 13) Balance cut & fill below landfill

✓ 14) Scarify and compact landfill excavation and no rocks

✓ 15) Protective soil cover - silty sand preferred.

✓ 16) System from waste up is

1) Waste
2) Select fill (12")
3) geotextile
4) geogrid
5) 60 mil HDPE
6) geogrid
7) geotextile
8) protective soil cover (12")
9) clay cap (12")
10) topsoil (6")

Subject _____ Project No. _____

By _____ Checked By _____ Task No. _____

File No. _____

Date _____ Date _____ Sheet 2 of 4

note on detail (bottom only)

? 17) Protective soil cover may be contaminated within landfill

note on plan 18) North Lagoon - Contaminated runoff only no leachate

✓ 19) Minimize sludge runoff - solidify anything over 4,000,000 gal except for leachate lagoon.

✓ 20) Leachate Pond for leachate only. = working cell to L. Lagoon = non-work cell to N. Lagoon or ~~Pond~~ L. Lagoon 7 days min. in which ~~to~~

✓ 21) Leachate and contaminated runoff may be stored in open impoundments.

✓ 22) Leachate Pond

1) COMPACTED PREPARED EXCAVATION (SPECIFY COMPACTION)
2) 60 mil HDPE
3) DRAINAGE NET
4) 60 mil HDPE

✓ 23) Pond sized for leachate only ~~and contaminated runoff from landfill only~~

~~24) Runoff in landfill goes to North Lagoon~~

✓ 25) Contractor can handle runoff to No ~~whichever~~ pond ~~he feels necessary.~~

✓ 26) Rainfall on exposed waste will be controlled ~~collected~~ by Contractor.

✓ 27) The Leachate Lagoon design is not negotiable by Contractor. Size should be shown as minimums.

✓ 28) North lagoon minimum design is provided. The Contractor sizes the Pond. Pond cannot store leachate. This pond also holds final decon waters.

✓ 29) Provide the contractor design storm data.

✓ 30) Make the runoff control and pond size the Contractors responsibility

✓ 31) HDR stated assumptions could be made to size ponels. These must show up in design memo.

✓ 32) North Lagoon Design

1) Prepared base in excavation
2) 60 mil HDPE

✓ 33) Evaluation criteria

1) Ability to meet pumping schedule by Sept. 1, 87
2) Time to complete schedule.

✓ 34) Provide information on liquid characteristics and pumping experience. Recommend pump types...!

✓ 35) Require performance from pumps.

ie rates, head, etc.

✓ 36) Talk about effect on centrifugal pumps (impellers) & crystallization

Note: Contr. to supply 50 additional Ld. 37) Location of tanks and contractors responsibility at the interface.

✓ 38) Double walled force main

✓ 39) Contractor proposes pumping schedule.

✓ 40) Tank schedule.

Subject _____ Project No. _____

By _____ Checked By _____ Task No. _____

File No. _____

Date _____ Date _____ Sheet 3 of 4

41) Assume temporary berm control at tank storage.
42) Safety interface with Shell?
43) Performance Spec's for contaminated material removal and solidification
44) Off-gas results section
45) Minimum solidification for stability
46) Zone of Hazard - locate support outside this. temp. Seneca
47) Performance spec for in-situ
48) Any residual liquids will be absorbed and ~~be~~ part in land fill.
49) No rock hard material.
50) Note corrosive material.
51) Warnings against over solidification 100% saturated sludge : 1
52) Upper limit on fly ash quantity.
53) Specify paint filter and Quality Assurance Criteria
54) ~~Specify~~ Field solidification demonstration Contr. Requirements
55) Moisture content ~~QA~~ QA.
56) Don't let contractor get paid more for adding unneeded fly ash.
57) Cost plus for solidification
58) Research information on in-situ
59) Pigmill information in appendix
60) Clear that other solidification processes are acceptable
61) Mention off-gassing control
62) Look @ 1982 WES study for performance criteria for conceptualized solidification
63) Internal testing of material qualifications. Can the Contractor demonstrate solidification should be in evaluation.
64) Sample shipped to prospective contractors for experimentation?
65) Need off gassing results
66) Contaminated material removal - Contractor responsibility
67) Protect existing roadways
68) Haul Road Specs (berms?) Over the clean basin
69) Final roadway to waste pile and leachate pond
70) General spec on equipment decontamination so it covers whatever equipment is used. - Contractors responsi
71) Handling of North Lagoon following Construction - cont. resp.
72) Simple water treatment for disposal - Contractor responsibil
73) Site grading concept - not final contours
74) Deal with "hot spot" criteria and definition in excavation of waste.
75) Concept Solidification

staging area
summary of work
Detail of Contaminated Haul Road
subject to change as design progresses

Subject _____ Project No. _____

By _____ Checked By _____ Task No. _____

File No. _____

Date _____ Date _____ Sheet 4 of 4

✓76) Technical specs for wastepile and lagoons
✓77) SSQMP not needed - include quality in technical specs per say.
✓78) Definite guidance and minimum values for contractor packages such as SHORP
✓79) Air monitoring plan with certification in words
80) O & M Plan after 95%
✓81) Provide data so contractor can estimate pond size
✓82) Safety plan part of RFP Submittal
✓83) Mob. on July 23 on certain items
note on plans ✓84) Show excavation volume as estimate
note 85) Specify final grading results

HDR Internal Memorandum

To Bob Catton
Bruce Larsen

Date March 27, 1987

From Chuck Dreesen

Subject RMA - Basin F - WCC
Proj No 4008-02-34

CIVIL ITEMS STILL NEEDED FOR DESIGN COMPLETION

NOTE: This list contains information that was requested in memos of Dec. 23, 1986, Jan. 13, 1987, and Mar. 8, 1987.

1. Seeding types, rates, etc. (including cover crop and/or any requirements or desires for temporary erosion control).

2. Fly ash or other absorptive material mix ratio.
   NOTE: A mix ratio allowing an additional 10% has been used in sizing the waste pile. An additional 10% above this 10% will also be applied to the volumes to size the waste pile (120% x 400,000 C.Y. = 480,000 C.Y. ; USE 500,000 C.Y.)

3. Thickness of rip rap so that a volume can be determined.

4. A list of available standard plans and/or details from the Corps of Engineers.

5. Geotechnical properties of sludge and solidified sludge.

6. Geotechnical properties for clay liner.

7. Geotechnical properties for "Select Fill".

8. Geotechnical properties for top soil.

9. Geotechnical properties for Final Grading (removal and placement of berms).

Project Basin 'F' | Computed

Subject Change to RFP Status | Date 3/24/87 | Sht. 1 | Of

1) RFP - high criteria involvement

2) High Priority Item - Liquid Removal, in operation by Sept. 1, 87

3) Sacred Cows

- Wastepile Liner - start w/ minimal system & negotiate w/ CDOH.
- Pumping By Sept. 1, 1987
- Cost ≤ 1 Kmil or less

4) 12" Clay Cap on Basin w/ Top Soil & Seeding

5) Balance Cut & Fill for Interior Grading
Top 6" to be scarified & recompacted
Prepared Foundation
60 mil
Geodrain
Geotextile
Working Face
Waste
60 mil
Geodrain
Geotextile
Select Fill
24" Impervious Mtl. (12" Mtl, 12" Clay)
Topsoil

6) Leachate Lagoon
As Designed except no clay w/ Prepared base

7) Mtn. Lagoon
Design Pond Liner System
Contractor Sized w/ Criteria w/ min sized lagoon

Project | Computed

Subject | Date 3/24/87 | Sht. 2 | Of

8) Liquid Removal
Pump by Sept 1, 1987 ←
Contractor Furnished & Selected Type Pumps
Double Wall Force Main
Give Dates Tanks will be available

9) Solidification & Mtl. Handling
Performance Spec based on bench
test started by Apr 15

Min. unconfined compressive strength

10) Force wastepile & leachate pond

11) Roads equal to prior

12) Assume No. Pond is Dry

13) Meteorological Data for No. Lagoon
for sizing

SCHEDULE

INTERIM ACTION OF BASIN F

REQUEST FOR PROPOSAL

IN-SITU SOLIDIFICATION

Rcvd. from Rick Wilson on 3/24/87

ACTIVITY	ORIGINIAL DATE	CURRENT DATE	ACTUAL DATE
NTP TO A/E FOR DESIGN	12/12/86	12/12/86	12/12/86
REVIEW CONFERENCE 30%	12/29/86	01/14/87	01/14/87
PROJECT DELAY - START	01/14/87	01/14/87	01/14/87
PROJECT DELAY - END	02/23/87	02/23/87	02/23/87
DESIGN SUBMITTED 95%	03/02/87	04/10/87	04/10/87
WORKING SESSION TO PREPARE DRAFT RFP	04/15/87 04/17/87	04/15/87 04/17/87	04/15/87 04/17/87
WORKING SESSION TO REVIEW COMMENTS FOR DRAFT RFP	04/27/87 04/29/87	04/27/87 04/29/87	04/27/87 04/29/87
ADVANCED NOTICE TO BIDDER AND CBD ANNOUNCEMENT	05/01/87	05/01/87	05/01/87
REVIEW CONFERENCE 95%	03/30/87	05/08/87	05/08/87
COMPLETE RFP,AMENDMENTS TO BE ISSUED FOLLOWING FINAL DESIGN SUBMITTAL	05/13/87	05/13/87	05/13/87
ISSUE RFP TO BIDDERS	05/20/87	05/20/87	05/20/87
DESIGN SUBMITTED FINAL	04/13/87	05/22/87	05/22/87
PRE-PROPOSAL CONFERENCE AND SITE VISIT AT RMA	05/29/87	05/29/87	05/29/87
PROPOSALS SUBMITTED CRITICAL SUBMITTALS -MOB/SHERP 95%,FIELD BLDG WORK PLAN,EQ SHOP DRAWING -UTILITIES INSTALLATION -LIQUID REMOVAL SYSTEM -BREECHING DIKES,PUMPING -PILOT SCALE TESTING	06/26/87	06/26/87	06/26/87
SOURCE SELECTION BOARD REVIEW AND EVALUATION	06/29/87 07/10/87	06/29/87 07/10/87	06/29/87 07/10/87

SHORT LIST CONTRACTORS	07/13/87	07/13/87	07/13/87
PRESENTATIONS TO BOARD	07/14/87	07/14/87	07/14/87
FINAL SELECTION BY BOARD	07/15/87	07/15/87	07/15/87
AWARD OF CONTRACT	07/22/87	07/22/87	07/22/87
NTP FOR CONSTRUCTION	08/07/87	08/07/87	08/07/87
MOBILIZATION			
-SHERP FINAL*	07/22/87	07/22/87	07/22/87
	08/21/87	08/21/87	08/21/87
-WORK PLAN,QC PLAN FINAL*	07/22/87	07/22/87	07/22/87
	08/21/87	08/21/87	08/21/87
-FIELD FACILITIES*	07/22/87	07/22/87	07/22/87
	09/04/87	09/04/87	09/04/87
-SCHEDULE AND BONDING*	07/22/87	07/22/87	07/22/87
	08/21/87	08/21/87	08/21/87
UTILITIES INSTALLATION*	07/22/87	07/22/87	07/22/87
	09/04/87	09/04/87	09/04/87
LIQ REMOVAL SYSTEM	08/07/87	08/07/87	08/07/87
ORDER AND INSTALL*	10/21/87	10/21/87	10/21/87
BREECH DIKES, AND PUMPING	08/07/87	08/07/87	08/07/87
(PUMPING FOR 6 WEEKS)*	12/02/87	12/02/87	12/02/87
WASTEPILE,LINER,BERMS	08/07/87	08/07/87	08/07/87
	09/16/87	09/16/87	09/16/87
PILOT SCALE ABSORPTION*	08/07/87	08/07/87	08/07/87
IN-SITU SOLIDIFICATION**	09/09/87	09/09/87	09/09/87
ABSORPTION AND DISPOSAL	09/09/87	09/09/87	09/09/87
IN-SITU SOLIDIFICATION**	01/27/88	01/27/88	12/30/87
WASTEPILE CAP	01/27/88	01/27/88	12/30/87
	02/24/88	02/24/88	01/27/88
PERIMETER DIKE REMOVAL	01/27/88	01/27/88	12/30/87
	02/17/88	02/17/88	01/20/88
TOP SOIL CAP AND GRADING	01/27/88	01/27/88	12/30/87
	02/17/88	02/17/88	01/20/88
DEMOBILIZATION	02/24/88	02/24/88	01/27/88
	03/16/88	03/16/88	02/17/88

*THESE CRITICAL ELEMENTS WERE REDUCED BY FOUR WEEKS, AS A RESULT OF CONTRACTOR WORK COMPLETED DURING THE PROPOSAL SUBMITTAL PHASE

**CONSTRUCTION TIME FOR THE IN-SITU VS. PUG MILL SOLIDIFICATION WAS REDUCED ON THE ASSUMPTION THAT NO LEAD

TIME WOULD BE REQUIRED TO ORDER SOLIDIFICATION EQUIPMENT. THE DECISION ON IN-SITU VS. PUG MILL SOLIDIFICATION DEPENDS ON THE RESULTS OF THE BENCH TEST FOR ABSORPTION WHICH IS CURRENTLY UNDERWAY. A MAJOR PART OF THE BENCH TEST WILL MEASURE OFF-GASING OF AMMONIA AND VOLATILE ORGANICS FROM THE SOLIDIFICATION PROCESS.

Project	BASIN F-EMA	Computed	R. Grachek		
Subject	Change to RFP Status	Date	3/24/87	Sht. 1	Of 2

RFP CONSTRAINTS - "SHIELD COVER"

1. UNDER MATERIAL / LECHATE COLLECTION MATERIALS
2. PUMP TYPE
3. CLAY MATERIAL
4. SCHEDULE LIMITS
   - Total Project 18 mo.
   - Shell's Schedule
   - Mobilization
5. STATE OF COLORADO DEPT. OF HEALTH APPROVAL.
6. OFF GAS COLLECTION + TREATMENT CRITERIA
7. CLEAR HEIGHT OF FACILITIES
8. OVERALL SEQUENCE OF OPERATIONS
9. ACCESS / EGRESS PROVISIONS
10. FINAL ASTETHICS / APPEARANCE
11. RELIABILITY / SECURITY PROVISIONS
12. SITE ADMINISTRATION PLAN.
    - Meetings
    - Records
    - Health + Safety
    - Site Utilities
    - Quality Management
    - Safety
    - Support Facilities

Project		Computed	RWG		
Subject		Date	3/24/87	Sht. 2	Of 2

13. EXCAVATION / FILLING
    Guidelines
    - Stability
    - Placement
    - Topsoil
    - Compaction
    - Borrow Area

14. SOLIDIFICATION CRITERIA
    - Hardness
    - Workability
    - Leachate
    - Insitu

15. DEFINITION OF CONTAMINATED MATERIAL
    - Visual
    - Real Time
    - Measurement for Payment

16. SURFACE WATER CONTROL
    - Erosion
    - Runoff / Runon Containment
    - Minimize Contaminated Liquid Handling

17. LEACHATE COLLECTION + TREATMENT

18. 6" + 6' CRITERIA

19. COE CRITERIA

RECEIVED FROM RICK WILSON IN OMAHA 3/19/87 DJH

Received 7/21/86 at funding meeting Red Lion, Omaha

III. OUTLINE OF INTERIM CLEANUP PLAN FOR BASIN F

1. INTRODUCTION. The December 1985 Basin F Closure Plan submitted by the Army, documented a decision point in the fall of 1986 where interim action on Basin F would be critically examined and an action selected to deal with the most heavily contaminated sections of the Basin, liquid and solid. Studies leading to that decision point are ongoing and are currently on schedule. In an effort to determine if an acceleration of this interim decision point could be made, Department of the Army has requested that the Program Manager take expeditious steps to assess options currently available for Basin F as an interim action in response to the Colorado Department of Health revised closure plan and determine if an interim action could not be selected at the present time and implemented during 1986. The preferred plan, as discussed in the following paragraphs, has the following attributes:

a. It is functionally equivalent to the Colorado Department of Health's plan at a much lower cost ($12.5 million versus approximately $200 million). It is functionally equivalent in that it removes liquid from the environment, it isolates contaminated soils to prevent future groundwater contamination, and lastly, it closely meets the Colorado Department of Health's liquid removal schedule of seven months and is significantly shorter than the Colorado Department of Health's solid excavation schedule of 48 months.

b. It is consistent with a full range of final remedial action scenarios all the way from simple in-situ containment to total cleanup.

c. It allows time for testing and optimization of liquid destruction methods and soil treatment technologies.

d. It minimizes concerns and costs related to offsite transportation and disposal.

2. OBJECTIVE: To develop an interim action plan with respect to Basin F.

3. CONSTRAINTS: Several study constraints were placed upon the effort in order to guide consideration of possible interim removal alternatives.

a. Interim actions taken at Basin F should not preclude any future remedial actions for a final remedy. This constraint was particularly important to assure that an action taken at this point in time, albeit beneficial, would not preclude a cost effective permanent solution from being implemented. For example, solidification of the Basin F contents could be chosen now only to find that incineration is the preferred final remedy, thereby necessitating going back into the Basin and breaking up the cement-hardened material in order to attempt to incinerate it.

b. The interim action should be as cost effective as possible in its implementation.

c. Whatever is selected for an interim action should be initiated within calendar year 1986, preferably during this summer.

d. Actions that would be taken must be consistent with litigation issues between Colorado, Shell, and the U.S. Government, and the applicable or relevant and appropriate regulatory requirements.

4. ALTERNATIVES CONSIDERED: Many alternatives are available to deal with the Basin's contaminated liquids and solids. A broad range of these alternatives were considered.

a. As far as the liquids are concerned (approximately 3-4 million gallons of supersaturated solution with a saline and organic content), the alternatives include:

(1) NO ACTION.

(2) IN-SITU ABSORPTION - This action would consist of bringing dry soils, fly ash, and/or kiln dust to the Basin and placing this material

into the liquid pool in order to adsorb the free liquids prior to their disposal in an approved manner.

(3) ONSITE STORAGE - This alternative consists of storing the liquids, after removal from the Basin, either in existing tanks already on the Arsenal, or new tanks to be placed near Basin F, or creation of a new surface impoundment.

(4) ONSITE TREATMENT BY THE GOVERNMENT - Facilities exist on the Arsenal that could be used to chemically or thermally treat the Basin F liquid as a possible precursor to final disposal.

(5) ONSITE TREATMENT BY VENDOR - Many firms currently exist in the market place which offer mobile facilities which could be brought to the Basin and used to either incinerate, solidify, or chemically treat the Basin F liquid contents.

(6) OFFSITE TREATMENT/DISPOSAL - The preferred alternative in the Colorado Department of Health Draft Plan.

(7) COVER WITH GROUNDWATER CONTAINMENT/TREATMENT - This option would consist of placement of an impermeable cover over the Basin in conjunction with groundwater containment treatment. This is a two prong action, where possibly an air-inflated dome would be placed over the Basin to preclude volatile emissions and migratory wildlife impact with subsequent action taken to place the groundwater containment treatment north of the Basin to deal with leachate that would continue to be formed.

(8) ENHANCED EVAPORATION - This option involves operation of the existing enhanced evaporation system placed inside the Basin to continue the removal of liquid contents through natural evaporation.

b. Overburden/Liner/Subsoils alternatives are as follows:

(1) NO ACTION.

(2) IN-SITU CAPPING - Placement of clay or synthetic liner would take place throughout the 93 acres to prevent further infiltration of precipitation.

(3) CREATION OF A WASTE CONTAINMENT FACILITY INSIDE THE BASIN - This alternative would entail formation of a centralized storage facility to be placed surrounding contaminated solids. This facility would be capped and monitored as a waste pile during the interim period.

(4) OFFSITE DISPOSAL - This is Colorado's preferred alternative, whereby all material would be taken off Rocky Mountain Arsenal to a permitted offsite Resource Conservation and Recovery Act landfill.

5. PREFERRED ALTERNATIVE: After proceeding through a thorough alternative assessment as the currently available data, selection was made of the preferred interim plan for Basin F contaminated materials.

a. Liquids

(1) All remaining contaminated liquids within Basin F will be pumped into tank trucks and transported down D Street to carbon steel, epoxy phenolic resin lined storage tanks that are currently located along December 7th Avenue (See Figure). It is believed one through three of these tanks will be required, each tank having a current capacity of one million gallons. Tank preparation will consist of several activities to include tank inspections, evaluations of the berm, foundation construction, leak detection, cathodic protection, and compatability of Basin F liquid with different liner materials. It is currently projected that liner repairs within the tank and additional berm construction around the tanks will be made. Additional tanks will be constructed if: (1) the volume of Basin F liquid exceeds the capacity of the three one million gallon tanks; or (2) if the costs to upgrade any existing tanks significantly exceed the cost to construct new tanks. These new tanks may be placed adjacent to the existing tanks or may be placed adjacent to Basin F.

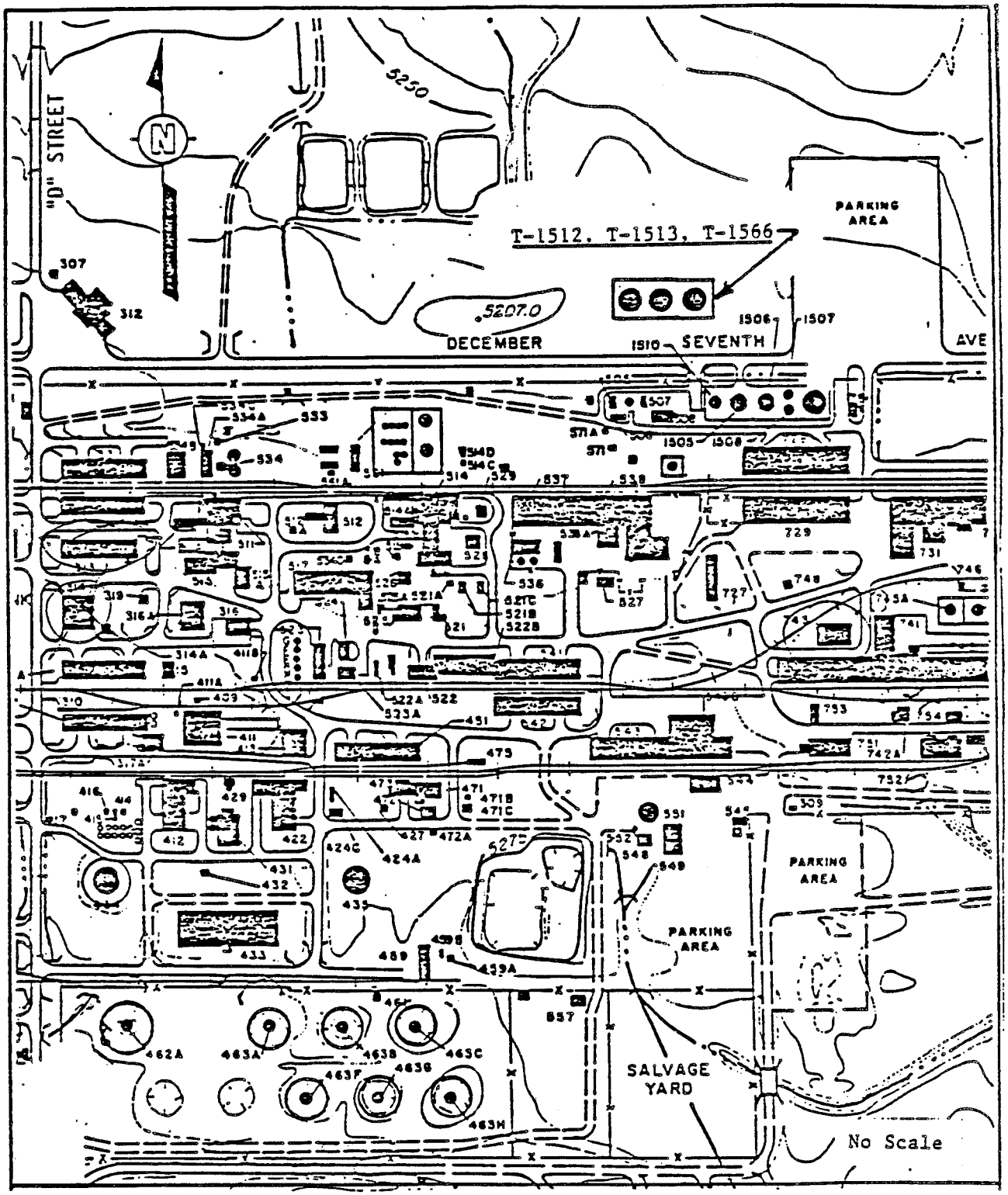


FIGURE. LOCATION OF PROPOSED SHELL STORAGE TANKS (T-1512, T-1513, T-1566)

(2) Pumping from the Basin to the tank trucks will be via commercially available sludge pumps (double-diaphragm, corrosion resistant, air-drive pumps with/PVC piping). A slight depression may be made in the overburden above the liner to facilitate draining of the Basin contents to the pump inlet or the existing sump structure used for the enhanced evaporation system may be altered as necessary to serve this purpose. Alteration of the area near the pickup hose may be necessary to create sufficient sump capacity to allow complete pumping of the Basin. A hot zone will be established so that the pump and the filling station are taken into account. Any personnel or vehicles crossing the hot zone will proceed through a decontamination, with vehicles being handled on an existing decontamination pad in the northeast corner of the Basin. A temporary personnel support complex will be established.

(3) Pumping and transportation will be conducted by a contractor procured by the Army through competitive Federal Acquisition Regulation procedures. A performance specification will be advertised according to the schedule shown in Enclosure 2. After selection of the contractor, a mobilization phase will take place. Technical plans will be developed specifying in detail the intended procedures for utilization in pumping and transportation. Health and safety plans will be developed. Laboratory certification will take place. Support facilities at the Arsenal will be upgraded or constructed as necessary and equipment will be brought onsite. During the operational phase, it is believed that pumping at an average rate of 20-30 gallons a minute can be achieved with higher rates expected during the early phases when the Basin's liquid head is at it's greatest level. For planning purposes, two shifts of operation per day are expected with a seven-day-a-week schedule shown. If, during the planning phase or operational phase, any unexpected conditions are experienced, immediate steps will be taken by the Government and the contractor to resolve them. For example, if pumping of the liquid is a problem, heat tracing of the pumping lines and/or addition of dilution water may be necessary in order to prevent crystalline formation within the pump parts. If pumping itself appears to present a problem, fallback techniques such as sludge excavation, hydraulic dredging, or belt presses will be available and brought on line.

(4) Comprehensive monitoring will take place throughout the interim period at the tank facilities to assure no spills as a result of tank failures. Upon cessation of pumping operations, any residual liquid in the Basin will be dried through the addition of absorptive materials prior to its incorporation with the other solids in the Basin. The cost of this phase of the interim action at Basin F is projected to cost approximately $1,000,000.

b. Solids

(1) An interim containment facility will be established in a ten acre area of Basin F. Contaminated overburden/liner/subsoils within the remaining 83 acres of Basin F will be excavated and brought to the ten acre facility. A temporary cap will be placed upon the containment facility and the facility will be monitored for its life.

(2) The ten acre area will be established based upon several criteria including; the presence of the intact asphalt liner, construction feasibility, and ease of material handling. A conceptual design of the facility will be established by the Government with the assistance of other parties prior to contractor selection. As with the liquid, a competitive procurement contract will be awarded through expedited Federal Acquisition Regulation procedures. This contractor's mobilization phase consists of similar activities as described above and will be phased in such a way as not to inhibit operations being conducted for liquid removal. It is believed that the ten acre site will be in the southwest area of the Basin so that logistical problems with the liquid removal contractor in the northeast section will not occur. The ten acre site will undergo close field inspection prior to any facility construction. Testing will be conducted on a grid pattern throughout the ten acre site to assure the integrity of the existing Basin liner. Debris will be removed from the site and grading may take place as required, to level the site with the necessary slope for underdrain construction.

(3) During the early design phase, additional detail for the underdrain system will be developed. Currently, it is expected that this

system will entail placement of a PVC drainage field directly on top of the 12 inch overburden, currently at the site. Placement of additional sand and/or liner material will be considered to assure integrity of the underdrain system during placement of the excavated materials.

(4) Excavation will take place using the best engineering calculations from the ongoing remedial investigation data. Currently, this excavation criteria is anticipated to be 6 inches below the liner, where the liner is intact, and 6 feet below the liner, if the liner is absent. Additionally, it is expected that field conditions utilizing visual and real time monitoring equipment will dictate adjustment to the engineering criteria. The excavation will occur starting where all liquids are absent and the soils have had time to drain fully. The last portion to be excavated will be the northeast corner upon removal of fluids and absorption of residuals. All materials will be scraped and placed into the ten acre site and sloped as necessary for drainage and placement of a cap. As with the underdrain field, the cap will be designed prior to procurement. For current purposes, it is expected that the cap will consist of clay and/or synthetic materials, placed in such a way as to prevent infiltration of precipitation into the stockpile waste. Surface topsoil and seeding will be added to prevent erosion and windblown dust. The remaining 83 acres will be recontoured, covered with a clay cap, and revegetated. New groundwater monitoring sites within the Basin and existing monitoring sites around the Basin will be closely examined throughout the interim containment facilities life expectancy. The cost estimate for the solids containment facility is approximated at about $9,000,000.

c. Additional Considerations - Basin F is a 93 acre site situated in a complex area of the Arsenal where other possible waste sources exist, to include, but not limited to, sewer systems, adjacent surface lagoons, and contaminated groundwater flow. Noted here are additional actions taking place within the Section 26 area which may impact on cleanup activities at the Basin. Although these are not a part of the Basin F interim action, they are included in order to provide a full understanding of the related actions which are currently under consideration or now in progress by the Army.

(1) Sanitary Sewer - Action is underway to deactivate the North Boundary sanitary treatment plant through the construction of area treaters within the manufacturing and administrative complexes at the Arsenal. Upon completion of this construction, the sanitary sewer system will be plugged, since the sanitary sewer may be a transport mechanism of contamination either within the sewer itself or along the permeable bedding materials that the sewer system is placed in. A section of sanitary sewer will be removed adjacent to Basin F. This material will be stockpiled within the Basin in a manner similar to the method of disposition of the contaminated sewer system. Upon creation of the containment facility at Basin F, this material with the overburden/liner/subsoils will be placed within the facility.

(2) Groundwater Treatment.

(a) Action is being undertaken at the North and Northwest Boundary containment/treatment facilities to upgrade their performance through operational and design alterations. An intensive monitoring and evaluation phase is being planned to monitor the system's effectiveness and recommend any subsequent construction changes that may be necessary to assure system effectiveness.

(b) It is felt that, at this time, construction of an operational interim groundwater containment/treatment system north of Basin F is appropriate. This system will be placed directly adjacent to the Basin within Section 26 to treat the groundwater flow path leading to the north boundary area of the vicinity. The system will be constructed using modular leased equipment and simplified dewatering and recharge wells to facilitate expeditious construction and operation. It is felt that this system will provide a benefit by treating the contaminated groundwater leaving the Basin F area prior to its dilution and dispersion as it travels to the north boundary. The system will also capture and treat contaminated groundwater that underflows the Basin from the Basin A, Section 36 vicinity. Based on previous treatability studies, the anticipated treatment components are: pretreatment through filtration and lime addition, and absorption with granular activated carbon at a treatment rate of approximately 100 gallons-per-minute. The system may or may not be continued after completion of the

Remedial Investigation/Feasibility Study, pending results of the preferred final remedial action decision. Implementation of this action will again be through competitive Federal Acquisition Regulation procedures according to the schedule shown within the following sections.

(3) Remedial Investigation/Feasibility Studies - Numerous activities are ongoing and being planned for the Basin F area.

(a) Remedial Investigation action ongoing include:

(1) Phase I and Phase II soil studies within and adjacent to the Basin.

(2) Air monitoring of volatiles and particulates in the Section 26 area.

(3) Biota assessment of plants and animals also within Section 26.

(4) Increased effort for liquid characterization (volume and consistency).

(b) Endangerment assessment efforts ongoing associated with Basin F include determination of How Clean is Clean levels for residual Basin F soils.

(c) Feasibility studies include:

(1) Incineration evaluations, both novel and conventional, for Basin F liquids and solids.

(2) Solidification vendor demonstration(s).

(3) Alternatives assessment.

Remedial Investigation/Feasibility Study activities related to the Basin F liquid will be accelerated to as great a degree as possible, in that the Basin F liquid characteristics are quite a bit dissimilar from other waste on Basin F. If possible, a decision for the Basin F liquid will be made prior to the decision process related to the remainder of the Arsenal.

6. COST ESTIMATE: Enclosure 1.

7. SCHEDULE: Enclosure 2.

8. SELECTION OF FINAL RESPONSE ACTION: The selection of a final remedy for Basin F will occur not later than April 1, 1988.

Enclosure 1

COSTS ESTIMATES

ITEM	DESCRIPTION	COST ($M)
General Facility	Fencing, roads, pumping station, decon area, holding area, and temporary trailers	1.5
Site Characterization	Current Remedial Investigation	0
Storage Tank	Rehabilitation of existing tanks, Shell furnished	0
Truck Haulage of Liquids	25 trucks 8 loads per day	~~0.3~~ 0
Prep Containment Facility	Rework overburden and install drainage system on 10 acre site	0.4
Load/Haul Solids	400,00 cy onto 10 acre site	~~0.8~~ 0
Recontouring	Grading and reclamation on 83 acres	2.0
Cap Containment Facility	Liner and runoff system for 10 acre site	1.0
Revegetation		0.1
Demobilization	Included in other costs	0
Testing and Inspection	250 samples	0.5
Operations	Pumping decontamination and liquids hauling.	0.9
Health & Safety	Lump sum	0.2
		7.7M
Contingency	10%	0.8
Overhead and Profit		1.5
Funding and Design	.5%	0.1
Supervision and Admin	5.5%	0.5
		$10.6M

12/3/86 due to SOW dated 11/17/86

HDR Internal Memorandum

To
BOB CATTON
BRUCE LARSEN

Date
MARCH 8, 1987

From
CHUCK DREESEN

Subject
RMA - BASIN F - WCC
PROJ NO 4008-02-34

CIVIL ITEMS STILL NEEDED FOR DESIGN COMPLETION

NOTE: THIS LIST CONTAINS INFORMATION THAT WAS REQUESTED IN A DECEMBER, 23 1986 AND A JANUARY 13, 1987 MEMO.

1. WASTEPILE GEOMETRY: THIS INFO WILL BE OBTAINED FROM DICK SPRAGUE. PRELIMINARY DETAILS ETC. WILL ALSO BE REQUESTED FROM FROM DICK.

2. BORROW AREA AND HAUL ROUTE FOR BORROW MATERIAL.
   NOTE: IT IS ASSUMED THAT THE BORROW REQUIRED FOR BERMS, GRADING ETC. WILL BE OBTAINED FROM THE HILL TO THE EAST OF BASIN F.

3. BORROW AREA AND HAUL ROUTE FOR LINER AND CAP MATERIAL (CLAY MATERIAL).

4. ACCESS ROADS AND THE REQUIREMENTS FOR THE DESIGN OF THESE ROADS INCLUDING WIDTHS, SURFACE MATERIALS ETC.

5. SITE FENCE REQUIREMENTS.

6. SEEDING TYPES, RATES ETC. (INCLUDING COVER CROP AND/OR ANY REQUIREMENTS OR DESIRES FOR TEMPORARY EROSION CONTROL).

7. FLY ASH OR OTHER ABSORPTIVE MATERIAL MIX RATIO.
   NOTE: A MIX RATIO ALLOWING AN ADDITIONAL 10% HAS BEEN USED IN SIZING THE WASTE PILE. AN ADDITIONAL 10% WILL ABOVE THE 10% WILL ALSO BE APPLIED TO THE VOLUMES TO SIZE THE WASTEPILE (120% x 400,000 C.Y. = 480,000 C.Y. ; USE 500,000 C.Y.)

8. THICKNESS OF RIP RAP SO THAT A VOLUME CAN BE DETERMINED.

9. A LIST OF AVAILABLE STANDARD PLANS AND/OR DETAILS FROM THE CORPS OF ENGINEERS.

10. ESTABLISHMENT OF A CONTRACTOR "ORDER OF WORK." THIS WILL BE USED TO DEVELOP DETAILS, TYPICAL SECTIONS ETC FOR ITEMS SUCH AS HAUL ROADS, LIQUID REMOVAL TRENCHES ETC THAT THE CONTRACTOR WILL USE IN CONSTRUCTION OF THE PROJECT.

3/87

RMA - BASIN "F" - WCC

INDEX OF SHEETS

SHEET NO.	TITLE	CONTENT
C 1	COVER SHEET	LOCATION, LEGEND ETC.
C 2	EXISTING CONDITIONS	EXIST. CONTOURS, ROADS, FENCE, POOLS, EVAP. PIPING ETC.
C 3	DRAINAGE DIVERSIONS, PUMP STATION, AND FORCE MAIN	EXIST. CONTOURS & ROADS, NEW ROADS, FENCE, POOLS, EVAP. PIPING, PUMP STATION, FORCE MAIN AND TANK FARM
C 4	FORCE MAIN	EXIST. CONTOURS, MAIN CONSTRUCTION CONTOURS, PROFILE
C 5	WASTEPILE BERMS, LAGOONS AND SOLIDIFICATION AREA	EXIST. CONTOURS, FENCE, FORCE MAIN, PUMP STATION, TANK FARM, LAGOONS, ROADS, NEW ROADS, WASTEPILE BERMS AND SOLIDIFICATION AREA
C 6	WASTEPILE	WASTEPILE BERM, EXCAVATED CONTOURS, INTERIOR CONTOURS, SECTIONS, LAGOON AND SOLIDIFICATION AREA
C 7	EXCAVATED CONTOURS	EXCAVATED CONTOURS, FENCE, LAGOONS, PUMP STA., FORCE MAIN, WASTEPILE BERM, TANK FARM, & SOLIDIFICATION AREA
C 8	GRADED CONTOURS	COMPLETED WASTPILE, GRADED CONTOURS AND NEW FENCE
C 9	COMPLETED CONTOURS	TOPSOIL CONTOURS, COMPLETED WASTE-PILE CONTOURS, AND NEW FENCE
C 10	TYPICAL SECTIONS OF BASIN GRADING	EXISTING, EXCAVATED AND TOPSOIL INCLUDED IN SECTIONS
C 11&C 12	DETAILS AND SECTIONS	WASTEPILE, CAP, FENCE, ROADS ETC.
C 13-C 20	CROSS SECTIONS	

Subject DESIGN & COST ESTIMATE INFORMATION TRANSMITAL

By D. HAWK Checked By

Date 1/19/87 Date

Project No. 86C8554P

Task No. 1

File No. 21947

Sheet 1 of 1

TO: MIKE HARRIS
HDR, OMAHA

FROM DAN HAWK
WCC DENVER

ATTACHED ARE FIGURES 1 THROUGH 4 WHICH BELONG IN THE "CONCEPTUAL DESIGN OF WASTE SOLIDIFICATION FACILITY FOR BASIN F CLOSURE" BY ARIX August, 1984. THIS REPORT WAS PREVIOUSLY SENT TO YOU 1/17/87.

ALSO ATTACHED ARE EXCERTS FROM DRAFT GUIDANCE DOCUMENT FOR PERFORMING EXPEDITED RESPONSE ACTIONS (ERA's) 11/27/85. THESE SHOULD BE HELPFUL FOR ESTIMATING INCREASE IN CONSTRUCTION COSTS DUE TO DEGREE OF HAZARD LEVELS AND FOR IDENTIFYING PERCENTAGE OF JOB RELATED COSTS ASSIGNED TO SEVERAL DIFFERENT CATEGORIES.

DAN HAWK
1/19/87

DRAFT GUIDANCE DOCUMENT FOR PERFORMING EXPEDITED RESPONSE ACTIONS (ERA's) 11/27/85

COST FACTORS AS A PERCENTAGE

1. Mobilization	- ranges from 2 to 5% of total direct construction costs; use 5% for preliminary estimate
2. Contingency	- ranges from 15 to 25% of total construction cost; use 25% for preliminary estimate
3. Engineering	- ranges from 7 to 15% of total construction cost; use 15% for preliminary estimate
4. Legal and Administration	- ranges from 1 to 5% of total construction cost; use 5% for preliminary estimate
5. Protection Cost Factor	- see Table 1 for different percentage at various protection levels; use most conservative value for preliminary estimate
6. Equipment O&M Costs	- 3 to 5%/yr of equipment cost
7. Insurance Cost	- 1% of total capital cost
8. Equipment Replacement	- 1% per year of capital cost
9. Labor Fringe Benefits for O&M Costs	- 20 to 30% of wages
10. Start Up and Shake Down Cost	- 5 to 20% of total capital cost; use 20% for complex systems
11. Supervision and Administration during Construction	- 8% of estimated project cost
12. Engineering and Design during Construction	- 15% of estimated project cost
13. Change Order Contingency	- 15% of construction cost
14. Non-component costs associated with a site where an onsite treatment facility will be built from "scratch" (applied to total construction costs).	
site preparation	- 1-10%
piping	- 8-15%
electrical	- 5-12%
instrumentation	- 3-10%

REF: DRAFT GUIDANCE DOCUMENT FOR PERFORMING EXPEDITED RESPONSE ACTIONS (ERA's) 11/27/85

AVERAGE PERCENT INCREASE FOR TOTAL COSTS AT FOUR DEGREE-OF-HAZARD LEVELS*

Unit Operation	Level B	Level C	Level D	Level A
Surface Water Controls:				
1. Surface Sealing - Synthetic Membrane	114%	119%	122%	126%
2. Surface Sealing - Clay	109%	119%	124%	127%
3. Surface Sealing - Asphalt	--	--	--	--
4. Surface Sealing - Fly Ash	--	--	--	--
5. Revegetation	117%	126%	126%	128%
6. Contour Grading	122%	133%	140%	146%
7. Surface Water Diversion Structures	135%	144%	151%	154%
8. Basins and Ponds	125%	138%	145%	150%
9. Dikes and Berms	190%	173%	176%	186%
Ground Water Controls:				
1. Well Point System	110%	117%	121%	128%
2. Deep well System	--	--	--	--
3. Drain System	128?	138%	143%	148%
4. Injection System	--	--	--	--
5. Bentonite Slurry Trench	109%	114%	132%	136%
6. Grout Curtain	--	--	--	--
7. Sheet Piling Cutoff	--	--	--	--
8. Grout Bottom Sealing	--	--	--	--
Gas Migration Controls:				
1. Passive Trench Vents	--	--	--	--
2. Passive Trench Barriers	--	--	--	--
3. Active Gas Extraction Systems	--	--	--	--
Waste Controls:				
1. Chemical Fixation (Solidification)	122%	129%	133%	137%
2. Chemical Injection	--	--	--	--
3. Excavation of Wastes/Contaminated Soil	307%	332%	397%	715%
4. Leachate Recirculation	--	--	--	--
5. Treatment of Contaminated Water	119%	121%	125%	128%
6. Drum Processing	201%	228%	264%	317%
7. Bulk Tank Processing	195%	248%	419%	549%
8. Transformer Processing	--+	293%	--+	--+

* Values given include 100 percent for base construction costs.

\+ This unit operation was deemed appropriate for performance only at Level C. Costs at Levels D, B, and A were not provided.

Source: "Worker Health and Safety Considerations: Cost of Remedial Actions at Uncontrolled Hazardous Waste Sites", Draft Final Report, 1983. SCS Engineers for US EPA, Covington, KY

HDR Internal Memorandum

To Mike Harris

Date January 13, 1987

From Chuck Dreesen

Subject RMA - Basin F - WCC
Proj. No. 4008-02-34

Response to Request for Civil Items Still Needed

NOTE: Items in parenthesis are those assumptions made at 12/29/86 HDR Basin F meeting.

1. Depth of Fluid - Average depths obtained in copy of 10/23/86 Holm, Roberts & Owen letter obtained from Rick Wilson, COE.
2. Depth of Solids Removal - (based on borings in Litigation Report)
3. Areas and Depths of Overexcavation - Telephone message of 1/3/87 with Rick Wilson indicated six foot removal below liner at borings 4620, 4626, and 4627; all remaining to be six inches.
4. Berm Geometry for Solids Containment - 4:1 slopes from Mike Harris per Sprague recommendation.
5. Ratio of Fly Ash for Solidification - (10% total fly ash)
6. Depth of Cover for Basin Cover and Details for Basin - (2 feet)
7. Depth of Cover for Solids Containment and Details for Basin - (4 feet)
8. Borrow Area for Cover Material
9. Liner Material and Depth for Containment Area and Details for Basin
10. Borrow Area for Liner Material
11. Site(s) for Solids Containment - Basin F-1 (south area of Basin F) per Mike Harris and Rick Wilson.
12. Site(s) for Liquid Containment - Received from Randy Grachek 1/9/87.
13. Access Road(s) and Requirements - Which roads need improving?
14. Site Fence Requirements
15. Runoff Containment Requirements for Basin "F" AFTER Removal and Cover
16. Seeding Types, Rates, etc. (including cover crop)

New Items

17. Confirmation of Excavation Acceptability Based on 1/14/87, 30% plans.

18. Should Excavation Be "Self-Draining" to Sump per 1/14/87, 30% plans?

19. Area and Height Requirements for Wastepile.

20. Areas of Rip-rap.

21. Requirements for Temporary Precipitation Storage or Evacuation During Construction.

22. Wastepile Design Parameters.

Reed Snow
R. Wilson 1/2/87
CA

HOLME ROBERTS & OWEN

ATTORNEYS AT LAW

SUITE 400
102 NORTH CASCADE AVENUE
COLORADO SPRINGS, COLORADO 80903

SUITE 900
50 SOUTH MAIN STREET
SALT LAKE CITY, UTAH 84144

1700 BROADWAY
DENVER, COLORADO 80290
TELEPHONE (303) 861-7000
TELECOPIER 861-4578
TELEX 45-4460

DENVER TECHNOLOGICAL CENTER
SUITE 900
8400 EAST PRENTICE AVENUE
ENGLEWOOD, COLORADO 80111

SUITE 400
1401 PEARL STREET
BOULDER, COLORADO 80302

EDWARD J. McGRATH

October 23, 1986

FEDERAL EXPRESS

Mr. Don Campbell
Department of the Army
Program Managers Office for Rocky Mountain Arsenal
Building E4585
Dbl. Trailer
Aberdeen Proving Grounds, Maryland 21010-5401

Re: United States v. Shell Oil

Dear Don:

Based on October 10, 1986 aerial photography of Basin F, Morrison-Knudsen Engineers (MKE) estimates that at that time the basin held 1.6 million gallons of liquid in three distinct pools. As discussed in my August 25, 1986 letter to you, the crystal beds that have formed in the low-lying areas may result in an overestimation of liquid volume. Also, even though it was understood from Arsenal personnel that the enhanced evaporation system had ceased operation for the winter, the enclosed copy of the orthophoto indicates free liquids remained on the "dry" areas upslope from the pools. This estimate does not include the volume of these liquids. The following table summarizes the results:

	Area	Average Depth	Estimated Value
North Pool	10.39 AC	0.32 FT	1,081,000 GAL
Southwest Pool	2.13	0.22	155,000
Southeast Pool	2.68	0.44	380,000
		Total	1,616,000 GAL ← 10/10/86

Mr. Ed Berry of RMA has informed MKE that 0.29 inches of rainfall was recorded at Basin F from October 10 through October 12 (after the enclosed photograph was taken). This much rainfall over 93 acres is equivalent to 730,000 gallons. This fact, along with the recognition that significant volumes of liquid probably remain in the void space contained in the soil cover, results in a current estimate of liquids in Basin F exceeding 2.3 million gallons.

TAL VOLUME [illegible]
[illegible]
730,000
[illegible]
[illegible] gallons

+ .24 inches of rainfall on 10/22, 23, 24
≈ 604,000 gallons

If you have any questions on the above information, please contact Al Notary at MKE or myself.

With best regards,

Sincerely yours,

Edward J. McGrath

EJM/jy/13119

Enc.

cc: E. Berry
A. Alavi (w/3 enclosures)
T. Bick (w/o enclosure)
R. Boonstoppel (w/o enclosure)

CAT
Y87

Slide Labels

(2) Fence, Enhanced Evaporation Piping, North Pool, Southwest Pool, Southeast Pool, 5 & 10 ft contours

(3) No Labels

(6) Volume = 2,149,300 gal. (N.), Volume = 200,500 gal. (S.W.), Volume = 470,400 gal. (S.E.)

(7) Fence, 5 & 10 ft contours

(8) No Labels

(9) Fence, 5 & 10 ft. contours

(10) Fence, 5 & 10 ft. contours

Legend

(14) Fence, Waste pile, 10 Acres, 33 Feet High

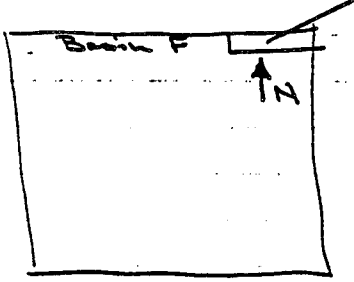
(15) No Labels

1/87

Civil Slides

1. Existing Conditions
   1"=200' Aerial w/ Overlay
2. Existing Conditions *
   Contours w/ All Features (No X-sect's)
3. Existing Conditions Perspective *
4. Liquid Drainage
   1"=200' Aerial w/ Overlay
5. Pumps And Force Main Liquid Containment Area
   1"=200' Aerial w/ Overlay
6. Liquid Depth Determination */
   Slide ⑦ w/ X-sect's
7. Drained Contours *
8. ~~Drained~~ Excavated New Contours ⇒ Yellow, no pipes
   ~~Perspective~~ Perspective *
9. Excavation Depths *
   Slide ⑦ w/ Green Depths
10. Excavated Contours *
    New Contours ⇒ Green
11. Contours Of Excavated vs. Drained *
    ≤2', ≤6', ≤8', ≤10', >10'
12. Volume And Area At Various Depths
    Graph
13. Solidification And Wastepile
    1"=200' Aerial w/ Overlay
14. Wastepile Contours *
    Slide ⑨ w/ Yellow Wastepile
15. Wastepile And Excavated Perspective *

* CADD Produced



1/87

① Locate Targets from Blueline and put into Model. This will be used to 'scale' mosaic aerial & to locate borings.

② Put tick marks for State Plane Coordinate System into model (from Blueline)

③ Cut cross-sections @ 100' centers from south to north based on coord. system as baselines

④ Get areas of 'Slurd'

⑤ Get area inside 'berm'

⑥ Family of Curves: for Volume vs/ Area based on 5' increments of depth, 2:1 side slopes

Recd 12/26

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FROM (SHIPPER)

T & S TECHNOLOGY

2627 REDWING LN
FORT COLLINS, CO

TELEX / PHONE (303) 226-0183 ZIP CODE 80526

TO (CONSIGNEE) PLEASE USE FULL ADDRESS, NO P.O. BOX

HDR Infrastructure
Attn: Chuck Dreesen
8404 Indian Hills Dr.
Omaha, NE

TELEX / PHONE ZIP CODE 68114

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FT	[illegible]

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1	2

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HDR Internal Memorandum

To: Mike Harris

Date: December 23, 1986

From: Chuck Dreesen

Subject: RMA - Basin F - WCC
Proj. No 4008-02-34

Discussion per meeting @ 12/23/86

Basin "F" Civil Items Needed

1. Depth of Fluid Borings
2. Depth of Solids Removal Borings
3. Areas and Depths of Overexcavation Rick (80%-6", 20%-6ft
4. Berm Geometry for Solids Containment (10' top, 3½:1)
5. Ratio of Fly Ash for Solidification Mike
6. Depth of Cover for Basin Cover 2'
7. Depth of Cover for Solids Containment 4'
8. Borrow Area for Cover Material Corps
9. Liner Material and Depth for Containment Area 1' granular
10. Borrow Area for Liner Material Corps 2' clay
11. Site(s) for Solids Containment - excavated, 2:1 side slopes
12. Site(s) for Liquid Containment 5' increments
13. Access Road(s) and Requirements
14. Site Fence Requirements
15. Runoff Containment Requirements for Basin "F" AFTER Removal and Cover Temp. Containment Pond (evaporation)
16. Seeding Types, Rates, etc. (including cover crop)

NOTE:

Data-information for items 1 through 12 are needed by 1/2/87 to meet 1/14/87, 30% On-Board Design Review Conference.

Meeting 12/24 @ 2:00

HDR Internal Memorandum

To Paul Ombuni

Date Dec 19, 1986

From Nick Kaplan

Subject Basin F.

The following hardware and software is the minimum required for the timely completion of the project.

- IBM PC { the one in the Cad Room has a faulty parallel port and drive
- High speed printer
- Procomm software

An IBM PC with harddrive and Innovative Smartware would be extremely helpful.





TGS Technology, Inc.

December 19, 1986

HDR Infrastructure
ATTN: Chuck Dreesen
8404 Indian Hill Dr.
Omaha, NE 68114

Dear Mr. Dreesen,

Enclosed per the request of Mr. Bill Schwening, U.S. Army, Corps of Engineers, is a 9-track magnetic tape containing MOSS EXPORT data as specified by Mr. Schwening.

Sincerely,

Paul D Harrison

Paul D. Harrison
Division Manager

enclosure

HDR Internal Memorandum

To File

Date 12/12/86

From Chuck Dreesen 221-4871

Subject 12/10 Meeting w/ COE

Met w/ COE (Rick Wilson, Bill Schweiger 221-4614 & John ?) Picked up several reports concerning Basin 'E'. Also picked up mylars for Basin 'E' and several plan sets for format style.

Received from Bill S aerial negatives to create a mosaic background.

Rick & Bill said that tape would be completed by 12/19/86. This would include documentation of data, plot of contours and final tape.

Rick asked what progress we'd made to date. I said that we (HDR) had not been able to be productive on the civil side w/ having the completed tape, contours and documentation. Rick asked what we'd have for 12/29 meeting and if we had any problem moving it to 1/5/87. I said that we (HDR) then Woodward Clyde should be sending a letter asking to move the meeting date for the 30% to 1/15±. Rick said that they (COE) would try to schedule meeting @ 1/15± in Omaha.

Rick asked what this delay would cause. I said that we (HDR) had discussed it amongst ourselves and that if we received the completed tape on/by 12/19 the 1/15 and Mar 2 completion should be OK. We also felt that receiving tape after 12/19 would move back Mar 2 date an amount equal to the delay.

HDR attendees: C. Dreesen, D. Meier & N. Kaplan

November 26, 1986

Department of the Army
Omaha District, Corps of Engineers
1612 U.S. Post Office and Courthouse
Omaha, Nebraska 68102-4978

Attn: MROSD-C

RE: Design Services, Basin F Interim Action, Rocky Mountain Arsenal, Colorado
Proposal No. 86-P-8554-P

Modified Original Fee Proposal (November 17, 1986) to Reflect Negotiations Held on November 24 and 25, 1986

Gentlemen:

We have prepared this Proposal in response to your Letter Request dated 27 October 27, 1986. The U. S. Army Corps of Engineers (COE) has requested that Woodward-Clyde Consultants (WCC) prepare this Fee Proposal to provide design services for interim action at Basin F at the Rocky Mountain Arsenal in Colorado. This work will be performed under U.S. Army Corps of Engineers Indefinite Delivery Contract No. DACW45-86-D-0067. WCC proposes to subcontract to HDR Infrastructure (HDR) major aspects of the work related to design, preparation of contract documents and site specific plans.

SCOPE OF WORK

General

This section describes WCC's understanding of the services to be provided. The scope of services for the project is contained in the Revised Scope of Services dated November 17, 1986, copy attached. The value engineering task (Item 71 of the Revised Scope of Services) has been deleted from the scope for this project. This proposal summarizes these services and the assumptions we made in preparing our proposal. We have assumed that the only activities requiring field presence will be the initial site visit and the on-site plan in-hand inspection. The Revised Scope of Services should be referenced for detail not included in our proposal. The primary intent of our services will be to design interim actions for Basin F including:

- Facilities for removal and transfer of contaminated liquid from Basin F to on-site storage tanks
- An interim solid storage containment facility wastepile
- Preparing specifications for partial solidification and removal of Basin F overburden/sludge to the designed wastepile
- Excavation and transfer of the Basin F liner and contaminated subsoils to the wastepile

Our services have been subdivided into six separate tasks: (1) information review, studies and analysis, (2) design and preparation of Contract Documents, and cost estimates (3) preparation of special plans and providing permitting assistance, (4) site visits and official meetings, (5) Value Engineering review (since deleted), and (6) project coordination/management. Our understanding of the services we are to provide for each of the six tasks is described in the following subsections.

Task 1: Information Review, Studies and Analysis

This task encompasses the activities covered under Section 2.a., items (1), (6), (12), (13), (15) and (16) of the Revised Scope of Services.

Our work for this task will involve the review of reports, studies and data selected by Corps personnel to obtain information that will be of use in design of the interim actions. For the purposes of this fee proposal, it has been assumed that 10 to 12 reports/studies, will be provided by the Contracting Officer for our review. The review will include:

WCC/HDR a. Review of Site - Soecific Information Obtained from COE/RMA

- Physical setting (topography, geometry, geology, access)
- Local subsurface conditions (soil, rock, water)
- Waste characterization (chemistry, toxicity, migration of liquids and volume of solids)
- Other pertinent site information (meteorology, precipitation and runoff data, etc.)

WCC/HDR b. Review of Technical Studies Pertinent to Interim Action

- Waste storage concepts and requirements
- Waste solidification procedures and results of studies by WES
- Geomembrane compatibility with site waste and liquids (WES studies)
- Clay liner applicability
- Internal drainage considerations (plugging, crystallization)
- Air toxics (if applicable)
- Mechanical equipment performance (pumps, pipes)

WCC c. Review and Analysis of Geotechnical Aspects

- Slope stability
- Settlement
- Trafficability
- Erodability of soil (water, wind)
- Dust generation
- Relationship of groundwater to proposed structures

The basic assumption made for this task is that no additional data acquisition (field tests) are required, except for permeability testing (water) of clay liner material, since sufficient information already exists

to develop design criteria. Therefore, the task involves reviewing, analyzing and digesting the existing pertinent information and data and extracting from it the conclusions necessary for design and preparation of Contract Documents (plans and specifications, construction schedule and cost estimates, and various plans such as SSQMP, SSSP, etc.).

WCC WCC will complete laboratory tests on samples of clay liner material to provide data on the engineering performance characteristics of the materials and to provide design criteria for the clay liner. Assumptions integral to this task are the following: (1) the samples to be tested will be provided to WCC by the COE, (2) the samples are not contaminated, and (3) the COE will provide analytical test results to assure the samples are not contaminated. Tests that will be performed include: specific gravity, gradation analyses, Atterberg limits, compaction, permeability, shrinkage limits, and natural moisture. The permeability tasks will be accomplished using tap water as a permeant.

HDE/WCC <u>Task 2: Design, Contract Documents and Cost Estimates</u>

This task will encompass the activities covered under Items (2), (4), (5), (7), (8), (9), (10), (11), and (14), of the Revised Scope of Services, Section 2.a., Sections 3, 4 and 9. We understand the design life of the facility is to be five years.

Major products are a Design Analysis Report, specifications and construction drawings, cost estimates, and a construction schedule. For the purposes of this fee proposal, it was assumed that the design includes a total of 30 construction drawings. The primary work for this task will involve:

- Liquid removal system design
- Road design *
- Coordination with Shell to check that the force main is compatible with their tank design
- Lagoon excavation design *
- Lagoon capping design
- Runoff collection/disposal design
- Overburden/sludge solidification system design
- Temporary solid waste storage facility design *
- Perimeter recontouring
- Preparation of a Design Analysis Report *

- Construction drawing preparation
- Construction specifications preparation
- Construction cost estimating *
- Construction schedule development
- Monitoring system design *
- Advertisement review
- Incorporation of client and agency review comments as applicable *

Based on the results of our November 12, 1986 meeting with representatives of the COE and WES, the following conclusions were reached and will be assumed for our design:

1. The flexible membrane liner for the wastepile will HDPE 60 mil.
2. Fly ash from a COE - specified source will be used as the admixture for overburden/sludge solidification.

HDR Task 3: Special Plans and Permits

This task encompasses the activities covered under Items 2b, 2c, 2d and 7h of the Revised Scope of Work. A Site-Specific Quality Management Plan (SSQMP) is to be prepared which serves as a working document to provide quality control and quality assurance during construction. A Site-Specific Safety Plan (SSSP) is also to be developed to address on-site health and safety requirements for all personnel involved in the project during interim action construction. The SSSP plan addresses decontamination facilities and protocols for personnel and equipment.

A Site Operation and Maintenance Plan for the completed interim action will also be prepared. This plan is prepared in such a way as to be in substative agreement with the applicable requirements of the Resource Conservation Recovery Act (RCRA).

The project will be designed in substantive compliance with applicable Federal, State and local environmental laws and regulations including those listed in Section 7h of the Revised Scope of Services.

WCC/HDR Task 4: Site Visits and Official Meetings

This task encompasses activities associated with review meetings with the COE and presentations to the Colorado Department of Health (CDH). Specifically, the following meetings will be included in this task:

- Initial site visit (one meeting)

* elements for which WCC will provide partial or total design criteria

- Meeting with the Corps of Engineers in Omaha to review and establish cost estimating procedures (one meeting)
- 30% design review meeting with the COE in Omaha (one meeting)
- 60% cost estimate review with COE in Omaha (one meeting)
- 98% complete review conference with COE in Omaha (one meeting)
- Presentation to the CDH in Denver (one presentation)
- On-site plan in-hand inspection at or near the completion of design (one inspection)

Task 5: Value Engineering Review (Deleted)

A Value Engineering (VE) review will be performed to identify design alternatives to enhance the technical quality and economy of the design. Special attention will be paid to high-cost items. Items to be addressed in the VE review are (1) estimated savings, (2) difficulty in implementing design, and (3) technical adequacy. The review will be accomplished by a team comprised of a total of four senior personnel from the firms of WCC and HDR. All representatives will be knowledgeable of construction costs in their field of specialty.

WCC/HDR Task 6: Project Coordination/Management (This task has been deleted.)

This task will entail project management to coordinate the efforts of the WCC/HDR design team to see that the various tasks are completed on budget, on schedule and in a technically sound fashion. Conference notes documenting results of all conferences and confirmation notices to provide a record of discussions and telephone conversations, etc., shall be maintained. Distribution of confirmation notices to other parties shall be made by the Government.

Other project coordination and management tasks include:

- Health and safety for WCC/HDR personnel
- Preparation of progress charts and reports
- Obtaining information on bidder interest
- WCC/HDR coordination
- Program management

PRICE AND SCHEDULE

The WCC/HDR estimate of cost to provide design services as described is $429,234. A summary for this price is provided in Table 1. Tables 2 through 7 present a breakdown of costs for WCC. Tables 8 through 14 present a breakdown of cost for our Subcontractor, HDR.

We plan to complete the work described in this proposal consistent with the schedule set forth in the Revised Scope of Services. Key milestone dates are shown on Table 15, attached.

Thank you for selecting our firm for negotiations in connection with the above-described services. We look forward to working with you on this interesting project.

Yours truly,

WOODWARD CLYDE CONSULTANTS

Kenneth H. Nass, P.E.
Senior Associate and Vice President

TABLE 15

HDR INFRASTRUCTURE

PROJECT SCHEDULE

Design and Construction		Procurement	
Design			
Proposal Due	17 Nov 86		
Complete Negotiations	1 Dec 86		
30% On-Board Design Review Conference	29 Dec 86		
98% Design Submitted to COE	2 Mar 87		
98% Design Review Conference with Written Comments	30 Mar 87		
		Advance Notice to Bidders	12 Mar 87
Final Design Submitted	13 Apr 87	CBD Starts	27 Mar 87
Reproduction	27 Apr 87	Advertisement (Plans and Specs Reproduced)	27 Apr 87
		Bid Opening	25 May 87
		Award	8 Jun 87
		NOTICE TO PROCEED	
		Mobilize	9 Jun 87
		Liquid Removal Begins	6 Jul 87

Note: Schedule is dependent on contract negotiations being complete on or before 1 Dec 86. If this date slips, all following dates slip accordingly.

A614

5th F
Rm 5012 500

Rick Waples	Environmental Engineer - COE
Dave Ray	Geotechnical Engineer - COE
Ali Alavi	Project Engineer - RM, RMr
Rick Wilson	Environmental Eng. - COE
Roger Stormo	Environmental Eng. COE
William F. Seipel	Civil Engr. COE
Stan Hanson	Cost Engr - COE
Kenneth H. Nass	Woodward Clyde Cons.
Jean-Yves Perez	Woodward-Clyde Consultants
Michael E. Harris	HDR Infrastructure
Robert D. Catton	HDR Infrastructure

TABLE 15

HDR INFRASTRUCTURE

PROJECT SCHEDULE

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Design			
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		Mobilize	9 Jun 87
		Liquid Removal Begins	6 Jul 87

Note: Schedule is dependent on contract negotiations being complete on or before 1 Dec 86. If this date slips, all following dates slip accordingly.

Centerra
A Bouygues Company

Telephone Conversation Record

Project DENF / MF | Project No.

Time | Date

~~Call to~~ Phone No. | ~~Call from~~ Phone No.

Discussion, Agreement and/or Action

Issues

RFP vs Design-Bid

1- Performanced Based Specs - simple no shop drawing proc.
2- Results Oriented
3- "Low" Owner Involvement in Details
4- Bullet Proof Performance Criteria
5- Simple bid form
6- Evaluation criteria includes cost and qualification - Complex Evaluation
7- Schedule open to proposers

1- Detail / Description - Specs extensive shop drawings
2. Process / Sequence oriented
3. High Owner involvement in Details
4. Performance Criteria is only spec criteria
5. Complex bid form due to adds / deducts
6. Evaluation Criteria is low bid
7. Schedule fixed by owner

cc:

HDR Infrastructure, Inc.
A Centerra Company

8404 Indian Hills Drive
Omaha, Nebraska
68114-4049

Telephone
402 399-1000

Transmittal

To Weitzel Civil Consultants

Attention [illegible] Date 3/17 Job No. 4008-07-34

Regarding Basin 5

We are sending you: [X] Attached [ ] Under separate cover via _____ the following items:

[ ] Shop drawings [ ] Prints [ ] Plans [ ] Samples [ ] Specifications

[ ] Copy of letter [ ] Change order [ ] Other

Copies	Date	No.	Description
			1"=400' Exist. Contours &
			Watershed w/ Graded Contours

These are transmitted as checked below:

[ ] For approval [ ] Approved as submitted [ ] Resubmit _____ copies for approval

[X] For your use [ ] Approved as noted [ ] Submit _____ copies for distribution

[ ] As requested [ ] Returned for corrections [ ] Return _____ corrected prints

[ ] For review/comment [ ] Other

[ ] For bids due _____ _____ 19 _____ [ ] Prints returned after loan to us

Remarks

Copy to

Signed

If enclosures are not as noted please notify us at once.

Centerra
A Bouygues Company

Telephone Conversation Record

Project: RMA - Basin F - WWC | Project No. 4008-02-34

Time: 4:00 | Date: 3/16/87

Call to: Dan Hawk / Dick Sprague | Phone No.

Call from: Chuck Dressen | Phone No.

Discussion, Agreement and/or Action

Soil Subsidence - Dick requested that I talk w/ WWC about subsidence beneath the wastepile & how it might affect the liner.

I talked w/ Dan Hawk @ WWC & he indicated that he felt that the subsidence should not adversely affect the liner but the drainage net as well as drainage on the wastepile should be evaluated.

Passed this on to Dick & he indicated that he is still concerned & that it should be discussed further.

cc: Dick Sprague & File

Centerra
A Bouygues Company

Telephone Conversation Record

Project: RMA - Basin F - WWC | Project No. 4008-02-34

Time: 11:15 | Date: 3/10/97

Call to: Dick Sprague | Phone No.

Call from: C. Deeszen | Phone No.

Discussion, Agreement and/or Action

1) Soils Tests Needed:
Typical Shrinkage Factors - Inplace vs. Optimum Densities

2) Locations & Borrow Sites (Clay & Sand)

3) Berm around Wastepile to be 5 Ft. height. Wastepile to be "stepped" like Dick indicated in 1/14 presentation material.

Subcells to be 100' - 200' wide draining to pipe in middle. Tests on sand will determine subcell width.

4) Precipitation for leachate design to be approx. 3 in. I telecopied precip. data to Dick for his use.

5) Dick to prepare typ. sections of wastepile & submit to us for drafting. We will generate wastepile geometry based on:
- 35 Ft. ht.
- 5 Ft. berm
- 700 Ft. width
- 500,000 C.Y. matl.
- 2 Ft. clay bottom liner
- 1 Ft. sand bottom leachate liner
- 2 Ft. clay top
- 1 Ft. sand/topsoil

6) Wastepile geometry to be sent to Dick ASAP

cc:

HDR

Telephone Conversation Record

Project Basin F Project No. 4008-02-34

Time 7:45 Date 1/7/87

Call to R Wilson 221-4871 Call from C Dreesen

Phone No. Phone No.

Discussion, Agreement and/or Action Project Name for Sheets

Hazardous Waste Cleanup
Interim Closure of Basin F
Rocky Mountain Arsenal, Colorado

Drawing Code DER6-400E1
Sheet #

use DER6-400E1 for sheet #1, DER6-400E2 for #2 etc.

cc: _____

HDR

Telephone Conversation Record

Project Basin F Project No. 4008-02-34

Time 10:15 Date 1/5/87

Call to C. Dreesen Phone No. Call from R. Wilson 221-4871 COE Phone No.

Discussion, Agreement and/or Action

- Areas for C&S excavation below liner:
  Borehole 4620
  Borehole 4626
  Borehole 4627

- Remainder of Areas at 6 in. excavation below liner

- Visual criteria for additional removal - seepage appears black and tarry with soil discoloration.

- If visual observation leads to additional excavation, max. excavation of C&S.

- Told Rick we will vary depths of excavation to get a handle on various sizes of containment facility.

- Rick said if we needed to talk w/ someone about pumps, he would get us in touch w/ person at 'Arsenal' who is familiar w/ old enhanced evaporation system. (Passed this info onto Mike H. & Randy G.)

- Told Rick our volume of fluid (based on info provided) was slightly less than 3 million gallons. Rick said tanks to have 4 mil. capacity.

cc:

HDR

Telephone Conversation Record

Project Basin F Project No. 4009-02-34

Time 9:30 Date 1/3/07

Call to John M. 221-4614 Call from Chuck D.
COE Phone No. Phone No.

Discussion, Agreement and/or Action

Has tape been mailed (supposed to have been shipped 12/30 per Bill S.)?
No, tape not completed until 12/31.

9:35 TGS Technology, Fort Collins CO
(303) 226-0183
Tape was shipped 12/31, should receive today (1/3)

9:40 Returned called to John M. to inform him of above.

cc:

HDR

Telephone Conversation Record

Project Basin 'F' Project No. 4029-02-34

Time 9:40 Date 12/31/86

Call to Rick Wilson CDE Call from C. Dorsey

221-4871 Phone No. Phone No.

Discussion, Agreement and/or Action

- Tape was sent last night, should receive today (including reminder of shores & roads)
- Rick has 15 x-sect. mylars
- Rick is working on excavation elevations, will call when complete (should be Fri. 1/2)
- There is monitor (stand) in large pool which can be used for that depth. 'Engineering Judgement' will be used to determine bottom geometry.

cc: _____

HDR

Telephone Conversation Record

Project RMA - Basin F - WWC Project No. 4008-02-34

Time 8:55 Date 12/24/86

Call to Tres Technology Call from C. Dressen

Fort Collins, CO Phone No. Phone No.
303-226-0183

Discussion, Agreement and/or Action

"Final tape" as COE (Bill Schwening) said would be sent 12/23 and recd by HDR 12/24 had not been prepared by Tres nor did they know they would be preparing another tape.

9:00 ~ call to Bob Carlton relaying above info. We also discussed schedule and I said that we would prepare order of magnitude quantities based on information discussed in 12/23 Basin F meeting.

cc:

Centerra
A Bouygues Company

Telephone Conversation Record

Project Basin 'F' | Project No. 4008-02-34

Time 3:50 | Date 12/22/86

Call to C Dressens (Phone No.) | Call from Bill Schuening CDF (Phone No.)

Discussion, Agreement and/or Action

Verification of final tape will not be done till tomorrow 12/23 morning. He said they would have copy of tape to me by/on Wed 12/24.

cc:

Centerra
A Bouygues Company

Telephone Conversation Record

Project: Basin "E" | Project No. 4008-02-34

Time: 10:00 | Date: 12/22

Call to: Rick Wulkan 221-4271 (COE) Phone No. | Call from: C. D[illegible] 1077 Phone No.

Discussion, Agreement and/or Action

- Status of Completed Tapes
  - Complete Tapes to be finished today (12/22)
  - 99% tapes sent Friday (12/19) located in mail room @ 11:00 HDR
- Documentation for tapes (one unit w/ 12/17 tapes)
  - COE (Bill 3 to send) to send
- Target information for aerials
  - COE (Bill 3 to send) to send
- Plot of contours
  - COE (Bill 3) to send

1:30 Bill Schumann (221-4412)
- 'Final' Complete tapes to be sent tonight or tomorrow. Documentation was explained. Targets for aerial lines plot should be ready for pickup tomorrow (11:00 E).

cc:

HDR

Telephone Conversation Record

Project: EMA - Basin 'E' - WCS Project No: 4004-02-34

Time: 4:10 Date: 12/2/96

Call to: Rick Wilson CDE Phone No. 221-4871 Call from: C. J. Brasen Phone No. 1972

Discussion, Agreement and/or Action: Computer Tape - Digital Terrain Model (DTM) for Basin 'E'

Background:

Nick Kaelin and I made several telephone contacts w/ R. Wilson and Bill Schmeiing of the CDE on 12/3 and 12/4 about obtaining the 'original' DTM tape of Basin 'E'. They indicated that they were preparing the 1" = 50' DTM and that the tape was in Colorado (Denver?) and that we would not be able to get a copy of the tape. R. Wilson indicated that they would be through with tape by Fri (12/6) and we should be able to get a copy of tape on Mon (12/9). Nick & I didn't understand why we couldn't get DTM copy

Nick and I talked w/ R. Wilson on 12/5

DTM and a report "copy" of the old 1" = 200' [illegible] of Basin 'E'. [illegible] ascertained that the CDE only has the mylar plots of Basin 'E' and is currently developing the DTM. R. Wilson said that they could make a copy of the tape (30-40% completed) at the end of next week (12/10) and could 'Fed Ex' it to us. He indicated that complete DTM would be done by Fri (12/13)

[illegible] R. Wilson [illegible] computer-generated plans plotted on CDE title blocks were OK. R. Wilson indicated that [illegible] providing [illegible] CDE title block

cc: [illegible]

CONTAMINATED LIQUID REMOVAL

Randall W. Hahl CKd By: BKL

BASIN F

CONTAMINATED LIQUID REMOVAL

1. PROCESS PHILOSOPHY

The objective of the liquid removal system for this project was to transfer up to 4 million gallons of contaminated liquid in Basin F to storage tanks constructed by others on the RMA site. Major considerations in this process include the fluid characteristics (both chemical and physical), time constraints, pipe friction and static head and acceptable equipment and material types.

The process pursued involved the utilization of a fixed pump station utilizing air-operated diaphragm pumps. The force main consisted of double contained polyvinyl chloride (PVC) pipe with leak detection and heat tracing. Flexible neoprene hose was considered for the suction side of the pump station. The air-operated diaphragm pumps were powered by an air compressor which is in turn powered by electricity.

2. PROCESS SPECIFICS

2.1 Pump Selection Criteria

The selection of a pump to transfer the Basin F liquid to the storage tanks was based on the history of previous equipment and selected performance criteria. Previous applications have utilized centrifugal and peristaltic pumps. Although the peristaltic pumps were used successfully for an enhanced evaporation process, neither type of pump appears to be adequate to pump a liquid with high viscosity against the calculated

RWG

friction losses and static head involved in transferring contaminated liquid to the tank farm. Therefore, these pumps were not considered for this application. The following design criteria was established for selection of a pump for this process.

- chemical compatibility
- ability to handle abrasives and slurries
- ease of maintenance
- time of equipment delivery
- liquid velocity within the pump

Of the remaining types of pumps, positive displacement pumps appear to best satisfy the criteria set forth. These pumps are designed for abrasive liquids and slurries, can be lined with chemically resistant materials, are easy to maintain, and can generally be delivered in four to six weeks after approved drawings are submitted. For these reasons, Air-Operated Diaphragm (AOD) pumps were selected. The internal wetted parts of the pumps should be constructed of 316 stainless steel and non-metallic parts such as ball valves, valve seats, and diaphragms should be constructed of neoprene. "Engineering and Construction Materials Compatibility Study - II, Final Report for Rocky Mountain Arsenal" was the basis for all pumping system materials selection.

2.2 Piping Selection Criteria

Based on COE direction, the Materials study and on cost parameters it has been determined that double contained PVC pipe equipped with a leak detection system and a heat tracing system would be an

RWG

acceptable system for transferring contaminated liquid to the tank farm. The pipeline should be as straight as possible without unnecessary bends or turns to minimize crystalization of the liquid caused by excessive turbulence. A straight pipeline and the use of AOD pumps limit the amount of turbulence. The leak detection system is required due to the hazardous nature of the liquid. Heat tracing reduces the effects of crystalization caused by cold temperatures. If the pipeline is constructed and operated during the summer, heat tracing may not be required. The suction line is composed of neoprene hose with a screen on the end to prevent large particles from entering the system.

2.3 In order to reduce the amount of solids and debris pumped to the storage tanks, several alternatives were considered (e.g. metal or concrete sumps). Because of the temporary nature of the pumping system (less than five months), digging a depression in the overburden was selected. The depression would be approximately 20 ft. x 30 ft and 1 ft deep. The suction line would also be fitted with a strainer.

2.4 Air Compressor - Utilities

A pad mounted and a portable air compressor were considered for providing the air supply to the AOD pumps. Since the pump station will remain in operation for less than five months, the portable air compressor would be more cost effective and thus was utilized for the design.

RWG

Utilities for the pumping operation include electrical power for the compressor and lights and water for equipment wash down.

3. LEVEL OF PROTECTION

All workers during construction and operation of the pumping system shall be in level B personnel protective equipment.

4. PERFORMANCE

Two AOD pumps have been considered for the pumping operation plus one standby pump. Due to the characteristics of the Basin F liquid, the pumps were to be limited to a maximum pumping flow rate of 100 gal/min.

BASIN F PROCESS ALTERNATIVES

PIPELINE:

1. We chose Sch. 80 PVC piping for the transfer line because the existing system is PVC piping and is apparently in satisfactory condition.

2. If the PVC is unacceptable then we would propose Sch. 40 high carbon steel for the inner pipe.

3. The outer spill containment pipe is proposed as PVC.

4. For leak detection we propose to use visible traps spaced throughout the transfer line.

5. At berms or road crossings, the transfer line will be run through a carrier pipe so as not to breech a berm or disrupt traffic flow.

PUMP STATION

1. The pump station was placed on a slab on grade for stability and to secure piping. Also the floating dock was secured to the slab.

2. A temporary slab could be constructed of heavy timbers connected together to form a slab and the suction hoses draped into the sump area that will be dredged near the pump station. This alternative is definitely cost effective.

AIR COMPRESSOR PAD

1. The compressor pad was to be a slab on grade.

Project BASIN F | Computed TJF | Ckd By: BRL

Subject PUMP DESIGN | Date 3/87 | Sht. 1 | Of 3

GIVEN:

USING 6" SCH. 40 STEEL AND A PUMPING DISTANCE OF 1020 FT.

THE SYSTEM CURVE CAN BE CALCULATED AS SUCH:

Hazen Williams $V = 1.318 C R^{0.63} S^{0.54}$ $C = 31.2$

1. AT 0 GPM THERE IS 23 FT OF STATIC HEAD

2. AT 75 GPM

$V = 0.84$ fps $R = \frac{6.065/12}{4} = 0.1264$ ft.

$$0.84 = 1.318(31.2)(0.1264)^{0.63} S^{0.54}$$

$$S = 0.009 \text{ ft/ft}$$

$$H_{Lf} = (0.009 \text{ ft/ft})(1020 \text{ ft}) = 9.2 \text{ ft}$$

3. AT 150 GPM

$V = 1.67$ fps $R = 0.1264$ ft

$$1.67 = 1.318(31.2)(0.1264)^{0.63} S^{0.54}$$

$$S = 0.03 \text{ ft/ft}$$

$$H_{Lf} = (0.03 \text{ ft/ft})(1020 \text{ ft}) = 30.6 \text{ ft}$$

Project BASIN F	Computed TJF	Ckd By: BRL
Subject Pump Design	Date 3/87	Sht. 2 Of 3

4. AT 225 GPM

$V = 2.5$ fps $\qquad R = 0.1264$ ft

$$2.5 = 1.318(31.2)(0.1264)^{0.63} S^{0.54}$$

$$S = 0.063 \text{ ft/ft}$$

$$H_{Lf} = (0.063 \text{ ft/ft})(1020 \text{ ft}) = 64.3 \text{ ft}$$

5. AT 300 GPM

$V = 3.33$ fps $\qquad R = 0.1264$ ft.

$$3.33 = 1.318(31.2)(0.1264)^{0.63} S^{0.54}$$

$$S = 0.106 \text{ ft/ft}$$

$$H_{Lf} = (0.106 \text{ ft/ft})(1020 \text{ ft}) = 108.1 \text{ ft}$$

6. AT 350 GPM

$V = 3.89$ fps $\qquad R = 0.1264$ ft

$$3.89 = 1.318(31.2)(0.1264)^{0.63} S^{0.54}$$

$$S = 0.142 \text{ ft/ft}$$

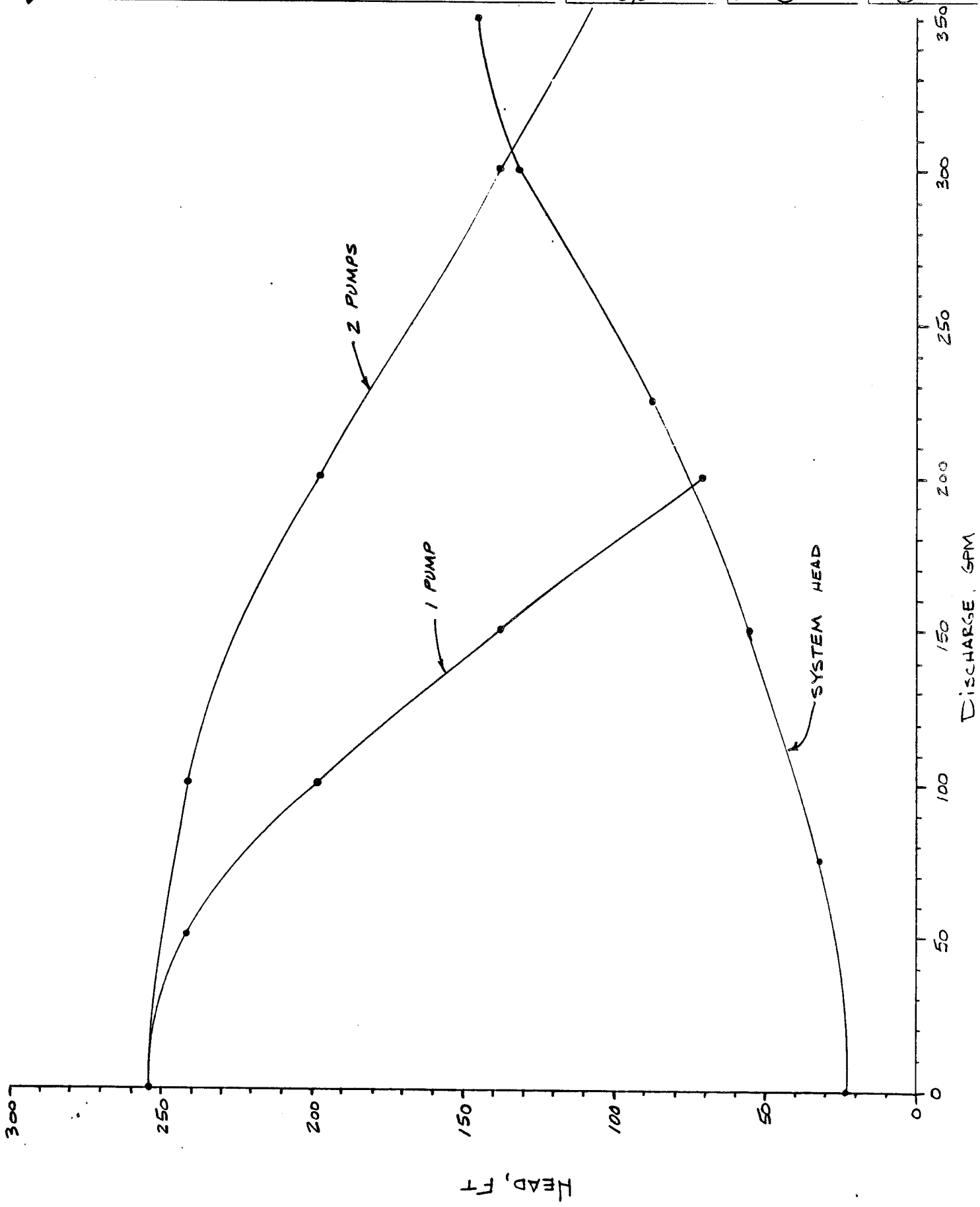
$$H_{Lf} = (0.142 \text{ ft/ft})(1020 \text{ ft}) = 144.8 \text{ ft}$$

Project

Subject

Computed TJF Ckd By: BRL

Date 3/87 Sht. 3 Of 3



Pipe Material: PVC
see Letter from S.L. Carlock dated 2/2/87 for viscosity

	A	B	C	D	E	F	G	H	I	J	K	L
1												
2			HEADLOSS CALCULATIONS									
3												
4			50 GPM	100 GPM	150 GPM	200 GPM	250 GPM	300 GPM	350 GPM	400 GPM	450 GPM	500 GPM
5			---	---	---	---	---	---	---	---	---	---
6	HEADLOSS, FT/FT											
7	4" SCH. 40		0.028	0.102	0.217	0.371	0.558	0.784	1.043	1.338	1.661	2.015
8	4" SCH. 80		0.037	0.131	0.279	0.473	0.717	1.005	1.331	1.720	2.124	2.601
9	6" SCH. 40		0.004	0.014	0.030	0.050	0.076	0.106	0.142	0.181	0.226	0.275
10	6" SCH. 80		0.005	0.018	0.038	0.064	0.098	0.137	0.182	0.234	0.290	0.353
11	8" SCH. 40		0.000	0.000	0.008	0.013	0.020	0.028	0.037	0.048	0.059	0.072
12	8" SCH. 80		0.000	0.000	0.010	0.017	0.025	0.035	0.046	0.059	0.074	0.090
13	10" SCH. 40		0.000	0.000	0.000	0.004	0.007	0.009	0.012	0.016	0.020	0.024
14	10" SCH. 80		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15												
16												
17	VELOCITIES, FPS											
18	---											
19	4" SCH. 40		1.26	2.52	3.78	5.05	6.3	7.57	8.83	10.1	11.35	12.6
20	4" SCH. 80		1.4	2.79	4.19	5.58	6.98	8.38	9.75	11.2	12.55	14
21	6" SCH. 40		0.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5	5.56
22	6" SCH. 80		0.62	1.23	1.85	2.46	3.08	3.69	4.31	4.93	5.54	6.16
23	8" SCH. 40				0.96	1.28	1.61	1.92	2.24	2.57	2.88	3.2
24	8" SCH. 80				1.05	1.41	1.76	2.11	2.46	2.81	3.16	3.51
25	10" SCH. 40					0.81	1.02	1.22	1.42	1.63	1.83	2.04
26	10" SCH. 80											
27												
28	HEADLOSS, FT FOR BASIN F LIQUID											
29	4" SCH. 40		66	173	339	562	834	1162	1538	1965	2433	2947
30	4" SCH. 80		78	215	429	711	1064	1483	1955	2520	3105	3796
31	6" SCH. 40		31	45	68	98	135	179	230	288	352	423
32	6" SCH. 80		32	51	80	118	167	223	289	364	445	536
33	8" SCH. 40		25	25	36	44	54	65	79	94	111	129
34	8" SCH. 80		25	25	39	49	61	76	92	111	132	155
35	10" SCH. 40		25	25	25	31	35	38	43	48	53	60
36	10" SCH. 80		25	25	25	25	25	25	25	25	25	25
37												
38												

BASIN F HEADLOSS CALCS

	A	B	C	D	E	F	G	H	I	J	K	L
39	HEADLOSS, FT FOR WATER											
40	4" SCH. 40		30	42	61	87	119	157	200	249	304	363
41	4" SCH. 80		31	47	72	104	145	194	248	314	381	461
42	6" SCH. 40		26	27	30	33	38	43	49	55	63	71
43	6" SCH. 80		26	28	31	36	41	48	56	64	74	84
44	8" SCH. 40		25	25	26	27	28	30	31	33	35	37
45	8" SCH. 80		25	25	27	28	29	31	33	35	37	40
46	10" SCH. 40		25	25	25	26	26	27	27	28	28	29
47	10" SCH. 80		25	25	25	25	25	25	25	25	25	25

Project BASIN F		Computed TJF	
Subject PUMP DESIGN	Date 3/87	Sht.	Of

FOR SYSTEM CURVES, I USED THE WILDEN DOUBLE DIAPHRAGM MODEL M-15

DESIGN CRITERIA:
- 3" INLET
- 3" DISCHARGE
- 110 PSIG MAX. AIR SUPPLY PRESSURE
- 180 SCFM AIR CONSUMPTION, EA

FOR IN-PLANT SUMP USE M-2 MODEL WITH CAPACITIES UP TO 30 GPM

RICWIL® piping systems

Engineered and marketed by
INTERGY, INC.
P.O. Box 418051 • Brecksville, Ohio 44141-8051
(216) 526-1600 Telex: 98-5299

estimate
THIS ~~PROPOSAL~~ FROM
Gartner & Assoc.Co.Inc.
5606 NO. 99th St.
Omaha,Ne. 68134
(402)572-6969 Rene Nelson

~~PROPOSAL~~

DATE 2-20-87

TO HDR INFRASTRUCTURE
8404 Indian Hills Drive
Omaha, Ne. 68114-4049

NAME OF JOB : Nerve Agent disposal Denver Co.

Attn: Thomas Furne

Tom, confirming our phone conversation today is a list of some of the specifics for the SAF-T-GARD piping system. I will send additional additional information as I receive. Thank you for your time and consideration. I will be in touch shortly.

SAF-T-GARD CONTAINMENT PIPING SYSTEM:

6" sch40 PVC carrier pipe - solvent welded
12" ~~10~~" sch40 PVC containment pipe- PVC welded
2" polyurethane foamed in place insulation
16" ~~14~~" final system size with a finished PVC outer casing, common stock couplings

HEAT TRACING:

The piping system shall be electrically heat tape traced. The heat tape and an alunimum wrap to prevent hot spots will be installed in a continous manner around the containment pipe before the insulation is foamed in place. The electrical connection point will be a Mid Feed System reaching out 1000 feet on eithor side. Thermostat(s) included. Voltage and breaker size to be clairfied. Heat tape to be designed for ambient temperature of 20°F and to maintain fluid at 80°,entering piping system at 55°.

MISCELANIOUS MATERIAL

Leak detection - sumps with sight glass, drain valve. Spacing as required.
Expansion joints- flanged neoprene type. As required.
Elbows and tee or "Y" fittings -factory fabricated,PVC ball valves
Carrier pipe supports -internal to the piping system
Baffles internal to the piping system

PIPING SYSTEM SUPPORTS:

To be field erected by others (Concrete pedistals,"U" straps)

230V 1ϕ 60Hz
need step down transformer
70 amp ~~heater~~ load
So use 100 amp br

Estimate price to include material,freight to job site, field service instructions

$ 85.00 per foot

RICWIL® piping systems

Engineered and marketed by

INTERGY, INC.

10100 Brecksville Rd., P.O. Box 418051
Brecksville, Ohio 44141-8051
Phone: (216) 526-1600 Telex: 98-5299

Safe-T Gard Specification

1.0 General

1.01 All hazardous materials as covered by this specification shall be contained in a two pipe system to prevent injury to personnel or contamination of the environment in case of line leakage. Where necessary, the containment system shall be insulated and heat traced.

The containment structure shall be constantly monitored for line leakage and shall have provisions for activating emergency procedures in case of leakage using a capacitance type electronic probe system with a control panel.

2.0 Containment Materials

2.0.1 Carrier Pipes

The carrier pipes shall be as required herein for the particular type of service.

Typical Options:
* Carbon Steel
* Stainless steel
* PVC (Polyvinyl Chloride)
* CPVC (Chlorinated polyvinyl chloride)
* PVDF (Polyvinylidene Fluoride)
* Polypropylene

(GIVE TYPE AND WALL THICKNESS ...)

2.02 Containment Casing

2.02.01 The containment casing shall be:

Typical Options:
* Carbon Steel
* PVC
* CPVC
* Polyethylene
* Stainless Steel

2.02.02 The containment casing shall be of full welded construction and shall be liquid tight.

2.02.03 The containment casing shall be sized to contain single or multiple pipes with sufficient clearance for field welding.

2.02.04 All containments shall be pitched to provide a positive drain point in the line with no pockets.

2.02.05 Unless insulated, the containment casing shall be coated. If belowground, the coating shall be:

Typical Options: * High Melt Point Asphalt
* Epoxy

If aboveground the coating shall be:

Typical Options: * Galvanized (not with S.S)
* Red Oxide

2.02.06 Container casing connectors for field weldling shall be a butt-weld deisgn to prevent any pockets or crevices for liquids to collect. Welding shields shall be provided for connectors on steel casings to protect the carrier pipes during field welding.

2.03 Carrier Pipe Supports

2.03.01 All carrier pipes shall be suitably spaced, guided, and supported within the containment pipe. Pipe supports shall be designed to maintain orientation of the carrier pipes throughout the system and shall permit axial pipe movement through the support.

2.03.02 Pipe supports shall be fixed to prevent movement during transportation, installation, and operation.

2.03.03 Accommodation for expansion of the pipe at all changes of direction shall be provided.

2.03.04 Supports shall be designed of materials compatible with the carrier pipe and shall be designed to permit spilled liquid to drain to the nearest leak detection point.

2.04 Insulation (if required)

2.04.01 For systems operating below 250°F, the insulation shall be polyurethane foamed in place between the containment and an outer jacket. The insulation shall have a minimum compressive strength of 50 psi. The density shall be minimum 3.5 lbs/ft . The thermal conductivity shall not exceed 0.14 BTU/inch/sq. ft./hr/°F at a mean temperature of 73°F.

(FOR HIGHER TEMPERATURE APPLICATIONS, CALL INTERGY, INC.).

2.05 Outer Jacket (when insulated containment is used)

2.05.01 The outer jacket containing the insulation shall be:

Typical Options:

* Galvanized steelwith Internal Spirally Locked Seam
* PVC Coated Galvanized Steel with Internal Spirally Locked Seam
* Aluminum with Internal Spirally Locked seam
* Stainless Steel with Spirally Locked Seam
* PVC
* Polyethylene

2.05.02 The jacket on all elbows and tee fittings shall be constructed of the same material as the straight sections. All fittings consisting of containment casing, heat tracing, insulation, jacket and carrier pipes must be factory fabricated. Field fabrication of fittings is not permitted.

2.06 **Baffles**

2.06.01 Baffles shall be provided in the containment at approximately _____ foot intervals, at tees and at building entrees. The baffles shall isolate any spilled liquid to that particular section of run and shall prevent leakage of liquid into buildings.

2.06.02 Each section of the containment piping between baffles shall be monitored with the leak detection system as specified herein.

2.07 **Anchors**

2.07.01 The containment piping and carrier pipes shall be anchored to control expansion movement. Plate anchors shall be welded to the containment casing and a separate baffle/anchor shall be welded to the carrier pipes a minimum of two (2) feet from the casing anchor to reduce heat transfer.

3.0 **Heat Tracing (if required)**

3.01.01 The prefabricated piping system manufacturer shall design and supply a factory fabricated electric heat tracing system for the insulated containment pipe.

3.01.02 The electrical heat tracing method shall provide a reliable safe system capable of uniformly supplying heat to the containment pipe throughout its entire length without hot/cold spots on the pipe. the heat tracing shall be:

Typical Options: * Skin Effect Current Tracing
* Heat tapes

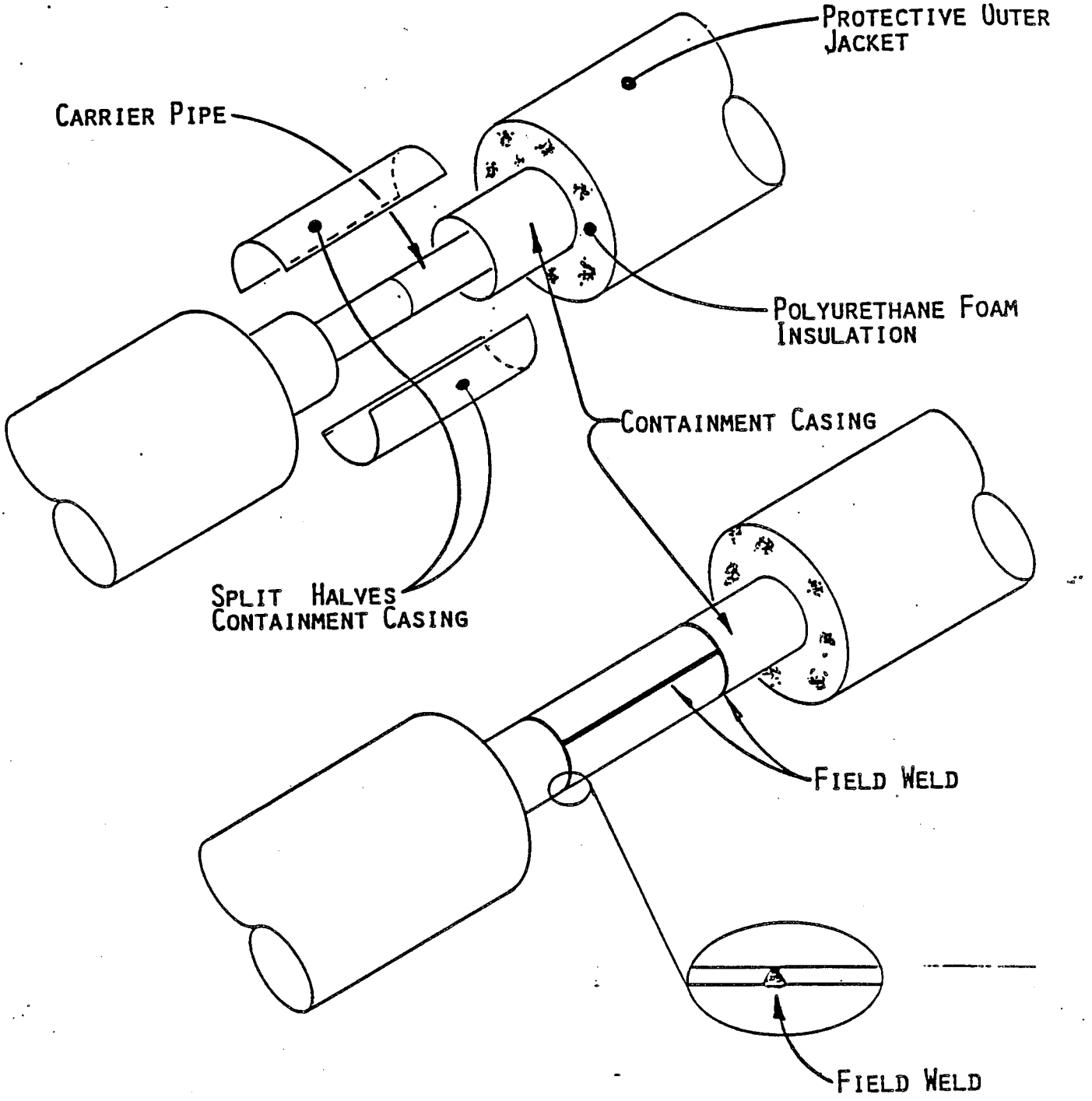
4.0 **Leak Detection**

4.01.01 Furnish a probe monitor type of leak detection system for the carrier pipe. The system shall consist of moisture sensitive probes mounted in the containment casing at appropriate locations such as low points or baffles and connected to a probe monitoring display panel.

4.01.02 Each probe assembly shall consist of a stainless steel probe unit with a stainless steel sensing tip and an integral transmitter mounted within an aluminum NEMA 4 conduit connection head.

The probe shall be able to sense non-conductive fluids such as solvents.

4.01.02 The leak detection system shall have the capabilities of initiating emergency procedures such as stopping pumps or controlling valves in case of any leakage.

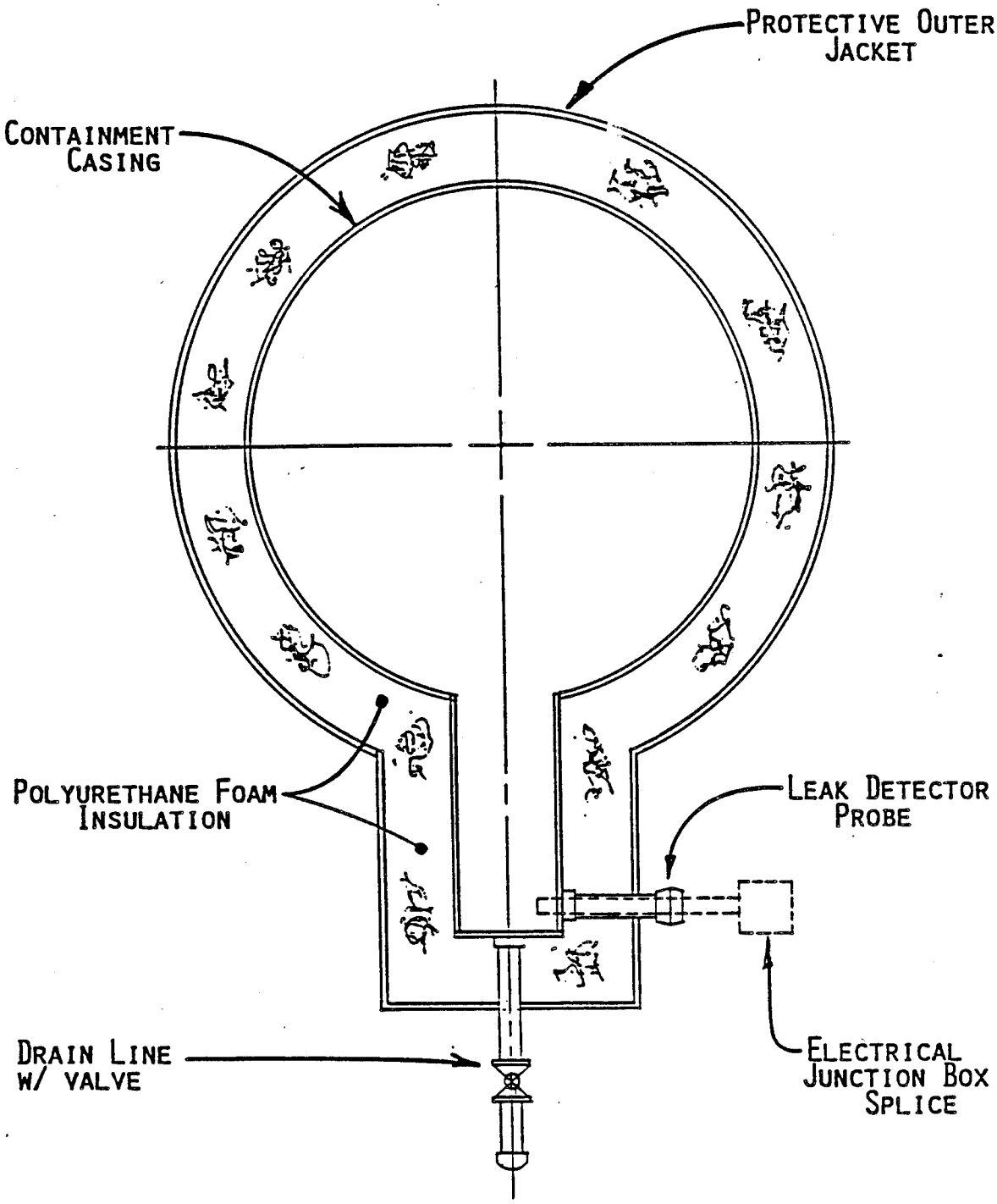


TYPICAL FIELD JOINT

RICWIL®
Insulated Piping Systems

RICWIL® piping systems
Engineered and marketed by
INTERGY

INTERGY INC.
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Insulated Piping Systems

DEPARTMENT OF THE ARMY
OMAHA DISTRICT, CORPS OF ENGINEERS
1612 U.S. POST OFFICE AND COURTHOUSE
OMAHA, NEBRASKA 68102-4978

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MEH

REPLY TO ATTENTION OF
Environmental Branch

February 2, 1987

Mr. Michael E. Harris, P.E.
HDR Infrastructure
8404 Indian Hills Drive
Omaha, Nebraska 68114

Dear Mr. Harris:

Reference is made to the 30% Design Review Meeting on January 14, 1987, regarding Basin F, Rocky Mountain Arsenal Project, Commerce City, Colorado.

The information you requested, the viscosity of Basin F, is as follows:

Temperature	Viscosity[1] of Water (cp)	Viscosity of Basin F Liquid (cp)[2] 8X	11X
10°C or 58°F	1.307	10.4560	14.3770
20°C or 68°F	1.002	8.0160	11.0220
30°C or 86°F	0.7975	6.3800	8.7725
40°C or 104°F	0.6529	5.2232	7.1819

[1]CRC Handbook of Chemistry and Physics, 53rd Edition, F-36

[2]RIC #8322BR02, Verification Studies on the Solidification of Basin F Wastes, Rocky Mountain Arsenal, WES, 1984, pages 25-29

If there are any questions regarding this information, please contact Mr. Duane Hines of this office, Telephone: 221-4817.

Sincerely,

S. L. Carlock

S. L. Carlock, P.E.
Chief, Environmental Branch
Engineering Division

5.1.3.1 Allowable Hoop Stress

5.1.3.1.1 With Casing Pipe

The following percentages apply to hoop stress in steel pipe within a casing under railway tracks and across railway rights-of-way:

(a) Seventy-two percent on oil pipelines.

(b) Fifty percent for pipelines carrying condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, and other petroleum products.

(c) Sixty percent for gas pipelines.

5.1.3.1.2 Without Casing Pipe

The following percentages apply to hoop stress in steel pipe without a casing under secondary or industry tracks:

(a) Sixty percent for oil pipelines.

(b) Forty percent for pipelines carrying condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, and other petroleum products.

(c) Fifty percent for gas pipelines.

5.1.3.1.3 On Right-of-Way

The following percentages apply to hoop stress in steel pipe laid longitudinally on railway rights-of-way:

(a) Sixty percent for oil pipelines.

(b) Forty percent for pipelines carrying condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, and other petroleum products.

(c) Forty percent for gas pipelines.

5.1.4 CASING PIPE

Casing pipe and joints shall be of metal and of leakproof construction, capable of withstanding railway loading. The inside diameter of the casing pipe shall be such as to allow the carrier pipe to be removed subsequently without disturbing the casing pipe. All joints or couplings, supports, insulators or centering devices for the carrier pipe within a casing under railroad tracks shall be taken into account.

TABLE 5.1.4.1

MINIMUM WALL THICKNESS FOR STEEL CASING PIPE FOR E 72 LOADING

Nominal Thickness Inches	*Nominal Diameter Inches*
0.188	Under 14
0.219	14 and 16
0.250	18
0.281	20
0.312	22
0.344	24
0.375	26
0.406	28 and 30
0.438	32
0.469	34 and 36
0.500	38, 40 and 42

When casing is installed without benefit of a protective coating, and said casing is not cathodically protected, the wall thickness shown above shall be increased to

the nearest standard size which is a minimum of 0.063 in. greater than the thickness shown except for diameters under 12¾ in.

5.1.4.1 Steel Pipe

Steel pipe shall have a minimum yield strength of 35,000 psi.

5.1.4.2 Cast Iron Pipe

Cast iron pipe may be used for a casing provided the method of installation is by open trench. Cast iron pipe shall conform to American National Standards Institute standard A 21. The pipe shall be of the mechanical joint type or plain-end pipe with compression-type couplings. The strength of cast iron pipe to sustain external loads shall be computed in accordance with ANSI A 21.1 "Manual for the Computation of Strength and Thickness of Cast Iron Pipe."

5.1.4.3 Flexible Pipe

For flexible casing pipe, a minimum vertical deflection of the casing pipe of 3 percent of its diameter plus ½ in. clearance shall be provided so that no loads from the roadbed, track, traffic or casing pipe itself are transmitted to the carrier pipe. When insulators are used on the carrier pipe, the inside diameter of flexible casing pipe shall be at least 2 in. greater than the outside diameter of the carrier pipe for pipe less than 8 in. in diameter; at least 3½ in. greater for pipe 8 in. to 16 in., incl., in diameter and at least 4½ in. greater for pipe 18 in. in diameter and over.

5.1.4.4 Length of Pipe

Casing pipe under railway tracks and across railway rights-of-way shall extend to the greater of the following distances, measured at right angles to center line of track. If additional tracks are constructed in the future or the railway determines that the roadbed should be widened, the casing shall be extended correspondingly:

(a) 2 ft beyond toe of slope.

(b) 3 ft beyond ditch line.

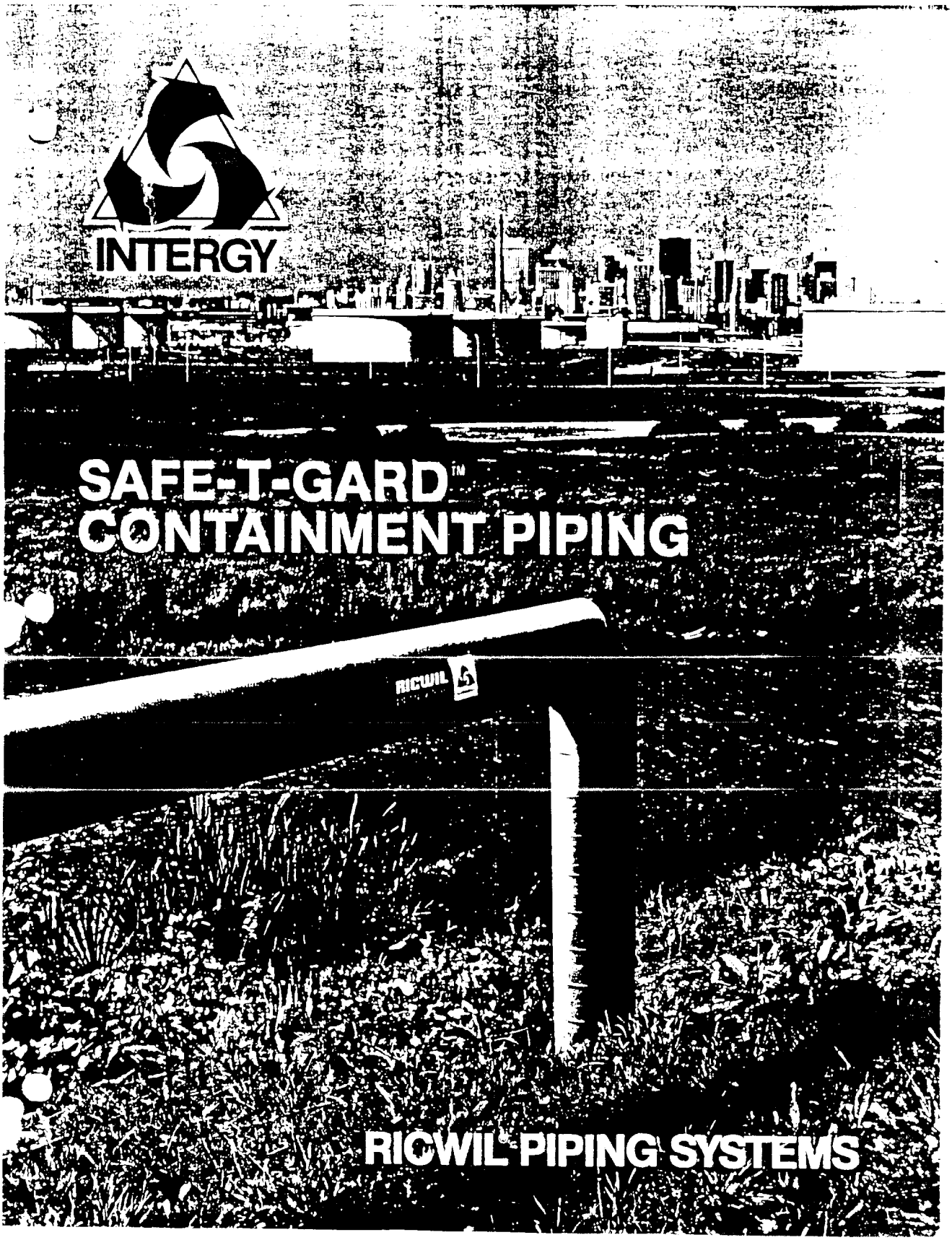
(c) A minimum distance of 25 ft each side from center line of outside track when casing is sealed at both ends.

(d) A minimum distance of 45 ft each side from center line of outside track when casing is open at both ends.

5.1.5 CONSTRUCTION

Casing pipe shall be so constructed as to prevent leakage of any substance from the casing throughout its length, except at ends of casing where ends are left open, or through vent pipes when ends of casing are sealed. Casing shall be so installed as to prevent the formation of a waterway under the railway, and with an even bearing throughout its length, and shall slope to one end (except for longitudinal occupancy).

Where casing and/or carrier pipe is cathodically protected, the engineer shall be notified and a suitable test made to ensure that other railway structures and facilities are adequately protected from the cathodic current in accordance with the recommendation of current Reports of Correlating Committee on Cathodic Protection, published by the National Association of Corrosion Engineers.


INTERGY
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SSR Rotary Screw Air Compressors 50-100 Horsepower

INGERSOLL-RAND AIR COMPRESSORS



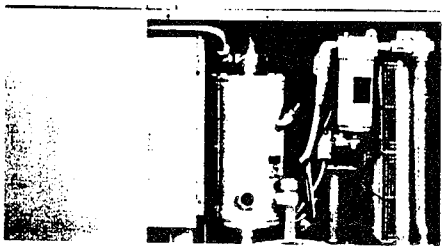
The new tradition in mid-range compressors.

The Ingersoll-Rand SSR rotary screw compressors have been successful for so long, you may wonder why we changed them at all.

Well, it's not a case of reinventing the wheel. What we have done is to improve the compressor design to give you even greater reliability and better performance.

As a result of this unique new package design, you get two special new features that are designed to increase the life of your compressor system. Tapered roller bearings have been incorporated into all SSR airends, to give you the most in performance and reliability. And a unique new cooler arrangement results in significantly reduced discharge temperatures and a 50% improvement in aftercooler CTD.

At the same time the compressor retains all the proven advantages and features you have come to rely on over the years: dedicated motor, integral gear drive, efficient separation system and solid state controls. And



access for routine maintenance is a snap with the SSR's easy-open enclosure panel.

Best of all, the new SSR is a complete compressor package including all of these standard features.

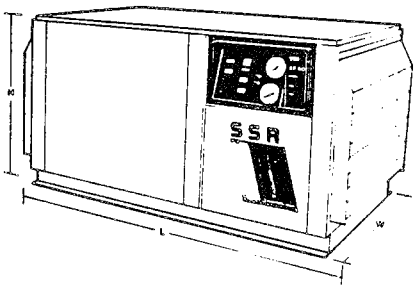
Standard Equipment

- Tapered roller bearing airend.
- Dedicated motor with over-sized bearings and Class F insulation.
- Rugged, proven integral gear drive.
- Efficient coolant separation system (less than 3 ppm carryover).
- Mounted full voltage motor starter.
- Complete control panel.
- Power-saving on line/off line control.
- Full complement of protective controls.
- Integral aftercooler (15°F CTD).
- Sound-attenuating enclosure (85 dbA*).
- Factory fill of SSR Coolant.
- Choice of air-cooled or water-cooled design.

Optional Equipment

- Star Delta reduced voltage starting.
- Low-sound enclosure (76 dbA*).
- Energy Recovery System (ERS).
- SSR Ultra Coolant (Factory fill).
- SSR H-1F Food Grade Coolant (Factory fill).
- Modulation control.
- Automatic start/stop control.
- Auto control selector.
- Protective shutdown annunciator.
- Multi-unit sequencer or Energy Management Center (EMC).
- TEFC motor.
- High dust inlet filter.
- High ambient cooling options.

*measured in accordance with CAGI-PNEUROP test code.



Specifications: 60 Hertz

Model	H.P.	FAD	Full Load Pressure	L	W	H	Wt.
SSR XF 50	50	220	100	80	42	41	1600
SSR EP 50	50	205	125	80	42	41	1600
SSR HP 50	50	190	150	80	42	41	1600
SSR XF 60	60	270	100	80	42	41	1800
SSR EP 60	60	240	125	80	42	41	1800
SSR HP 60	60	215	150	80	42	41	1800
SSR XF 75	75	360	100	87	52	54	2350
SSR EP 75	75	325	125	87	52	54	2350
SSR HP 75	75	275	150	87	52	54	2350
SSR XF 100	100	480	100	87	52	54	2950
SSR EP 100	100	445	125	87	52	54	2950
SSR HP 100	100	400	150	87	52	54	2950

NOTE: FAD (Free Air Delivery) is actual delivered CFM.

INGERSOLL-RAND®
AIR COMPRESSORS

Air Compressor Group
Ingersoll-Rand Company
Charlotte, North Carolina 28224

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HDR Internal Memorandum

To: File

Date: January 5, 1986

From: Randy Grachek

Subject: Basin F
Tank Site Analysis

Two Alternatives have been considered for the location of the liquid storage tank farm on the Basin F site. ~~Alternative A and Alternative B are shown on the attached map.~~

The following assumptions were made:

- Pump station inlet elevation = 5189'
- Pumping rate = 300 gpm
- Pipe sizes = 6", 8", 10"
- Pipe material = steel, sch 40

- Hazen Williams Formula

$V = 1.318C\ R^{0.63}S^{0.54}$

$C = 120^{*}(0.26)^{**} \doteq \underline{31.2}$ for new steel

* from Clark, Viessman, Hammer, Water Supply and pollution control, 3rd Edition. Pg. 143.

** Extrapolation of data presented by Mulbarger, Copas, Kordic, and Cash, Pipeline Friction Losses for Wastewater Sludges, 52nd WPCF Conf. Pg. 7.

- Bio-waste sludge and hazardous waste sludge C values are similar.

R = Hydraulic Radius, ft = $\frac{\text{flow area}}{WP} = \frac{D}{4}$ ***

S = Slope of Energy grade line, ft/ft

V = Velocity, ft/s

*** Round pipe flowing full

- 25' high storage tanks

<u>6" pipe</u> (6.065" ID)

V = 3.33 fps $\qquad R = \frac{\frac{6.065"}{12}}{4} = 0.1264$ ft

$3.33 = 1.318(31.2)(.1264)^{0.63}(S^{0.54})$

$\underline{S = 0.106\ ft/ft}$

Ckd By: BRL

8" pipe (7.981" ID)

$V = 1.92$ fps $\qquad R = \frac{\frac{7.981}{12}}{4} = 0.1663$ ft

$$1.92 = 1.318(31.2)(.1663)^{0.63}(S^{0.54})$$

$$S = 0.028 \text{ ft/ft}$$

10" pipe (10.020" ID)

$V = 1.22$ fps $\qquad R = \frac{\frac{10.020}{12}}{4} = 0.2088$

$$1.22 = 1.318(31.2)(.2088)^{0.63}S^{0.54}$$

$$S = 0.0092 \text{ ft/ft}$$

Alt A

Inlet Ele. = 5189.00

Outlet Ele. = 5187.00

Therefore Static H_L = -2' + 25' = 23'

Pipe length = 1020'

6" Pipe

H_{Lf} = 1020(0.106) = 108.12'

Therefore $H_{L\ Total}$ = 108.12' + 23' = 131.12'

8" Pipe

H_{Lf} = 1020(0.028) = 28.56'

Therefore $H_{L\ Total}$ = 28.56 + 23 = 51.56'

10" Pipe

H_{Lf} = 1020(0.0092) = 9.38'

Therefore $H_{L\ Total}$ = 9.38 + 23 = 32.38'

Ckd By: BRL

Alt B

Inlet Ele. = 5189.00

Outlet Ele. = 5189.00

Therefore Static H_L = 0' + 25' = 25'

Pipe length = 2320'

6" Pipe

H_{Lf} = 2320(0.106) = 245.92'

Therefore $H_{L\ Total}$ = 245.92 + 25 = 270.92'

8" Pipe

H_{Lf} = 2320(0.028) = 64.96'

Therefore $H_{L\ Total}$ = 64.96 + 25 = 89.96'

10" Pipe

H_{Lf} = 2320(0.0092) = 21.34'

Therefore $H_{L\ Total}$ = 21.34 + 25 = 46.34'

Minor pipe losses are similar for both alternatives as are losses in the pumping structure. Therefore, they are not included in the comparison.

There are several major advantages of using Alternative A.

- Less piping and installation are required resulting in cost savings of more than $90,000.
- Pumping can be done against a significantly lower head (lower cost).
- Shorter distances are required for the transport of hazardous waste, reducing the area of possible contamination in the event of a piping leak potential problems with crystalization in the pipe may also be minimized.

Ckd By: BRL

Cost Comparison - Source: Means 1987 Pipe Costs

Assume:

Sch 40 Steel inner pipe

Sch 40 PVC outer pipe - 4" larger than inner pipe

	Alt A		Alt B		
	Quan.	Cost	Quan.	Cost	Cost Differential
6" Inner	1020LF	$ 39,300	2320LF	$ 89,300	$ 50,000
10" Outer	1020LF	$ 33,700	2320LF	$ 76,700	$ 43,000
Total	1020LF	$ 73,000	2320LF	$166,000	$ 93,000
8" Inner	1020LF	$ 50,400	2320LF	$114,700	$ 64,300
12" Outer	1020LF	$ 40,100	2320LF	$ 91,300	$ 51,200
Total	1020LF	$ 90,500	2320LF	$206,000	$115,500
10" Inner	1020LF	$ 69,500	2320LF	$158,200	$ 88,700
14" Outer	1020LF	$ 52,000*	2320LF	$118,300*	$ 66,300
Total	1020LF	$121,500	2320LF	$276,500	$155,000

* Extrapolation based on means 8" and 12" pipe costs.

6" steel pipe = $38.52/LF
8" steel pipe = $49.41/LF
10" steel pipe = $68.13/LF

10" PVC pipe = $33.04/LF
12" PVC pipe = $39.31/LF
14" PVC pipe = $50.98/LF

Note: Pipe costs include installation and overhead but do not include pipe support or leak detection costs.

Ckd By: BRL

MATERIAL ABSORPTION

BASIN F

MATERIAL ABSORPTION*

(Mechanical Mixing)

1. PROCESS PHILOSOPHY

The material absorption process considered was based on mechanical mixing of contaminated material with absorbing agents. The purpose of this process is to absorb free liquids in the contaminated material and to minimize leaching of these liquids while still maintaining a material product which is able to be graded with standard grading equipment. A primary criteria in the absorption process is that the final product material cannot be allowed to harden excessively or exhibit significant pozzalanic characteristics because of probable final disposal plans for this material.

It is believed that a Class F Fly Ash would be a desirable alternative as the principle absorbing agent. Fly Ash in its dehydrated form is quite capable of absorbing free liquids from soil. Class F Fly Ash possesses a relatively low quick lime (CaO) content (approximately 6%) as opposed to Class C fly ash (approximately 28%). Fly Ash with a low quick lime (CaO) content is less likely to form a cementatious product than its high quick lime (CaO) counterpart and thus, it is more likely to produce the desired gradable product. Dry soil was also considered as an absorptive agent for this process. Mix ratios of these agents with contaminated material are subject to the results of bench scale testing.

*This method was not used in the engineers final cost estimate

An important consideration regarding the absorption process was the possibility of hazardous off-gasing as a result of fly ash addition to the contaminated material. It is quite possible that significant quantities of ammonia (NH_3) and volatile organic carbon (VOC) will be off-gased from the process. Provisions for ammonia scrubbing and carbon adsorption for VOC removal were considered. Off-gassing results from the bench scale absorption of Basin F materials will be a critical factor in the final design.

The absorption process involves delivery of contaminated material to a holding pad where it is loaded into hoppers and conveyed to pug mills. A contingency was made to also convey dry soil to the pug mills. Fly ash is delivered to the pug mills by rotary feeder and gravity from overhead storage silos. The material is mixed in the pug mills and discharged onto belt conveyors which move the material to the curing area. The curing area consists of a concrete slab with a temporary enclosure constructed to capture and dispose of ammonia and VOC off-gases. The material is subsequently hauled to the waste pile after the gases released are within guidelines determined by the Corps of Engineers.

2. PROCESS SPECIFICS

Various production rates were considered for this process. It was assumed that approximately 400,000 yd^3 of contaminated material would be absorbed at a design time of 14 hours per day for 120 days. This converts to a rate of approximately 240 yd^3 per hour. Assuming 10% fly ash addition by volume and no soil addition, the input volume would be 240 yd^3/hr and the output volume would be 265 yd^3/hr. These volumes

vary with the density of the fly ash, water content and density of the contaminated material.

Fly ash can be added either by volume or by weight. Because of the effects of consolidation on fly ash and the differing characteristics of the contaminated material, design was based on measuring the material and additives by weight rather than volume. Additive quantities and production rates are dependent on data obtained from bench scale and pilot scale tests because of the possible affects of ammonia off-gasing and material characteristics.

All work in this process area including both construction activities and operation are assumed to be done in level B personnel safety protection.

As stated before, it is of the utmost importance that the final product material be the consistency such that it can be easily graded with standard grading equipment. The material should resemble in physical characteristics a medium-stiff clay.

3. FACILITIES

The process facilities are composed of a reinforced concrete slab for the holding pad, process equipment area, and the curing area. The equipment area includes all process equipment and utilities. The curing area is composed of the slab and a portable tent for off-gas control. Major utilities running to the facilities are water and electrical power. These utilities are assumed to be available on the

RMA site. Water is to be used for equipment decontamination and for clay placement. Electrical power is used for lighting and equipment operation.

4. MAJOR EQUIPMENT

The major equipment proposed for this process is listed as follows:

a) 2 Pug Mills - 130 yd^3/hr ea.

b) 2 Belt Conveyors - 130 yd^3/hr ea.

c) 2 Belt Conveyors - 50 yd^3/hr ea.

d) 2 Belt Conveyors - 140 yd^3/hr ea.

e) 2 Fly Ash Silos - 15'0 dia x 40' high ea.

f) 2 Rotary Feeders - 10 ft^3/min max. ea.

g) 4 Feeder Hoppers - 4 yd^3 ea.

h) Site Electrical

i) Front End Loaders

j) Bulldozers

k) Cyclone (dust removal) (size to be determined by the Contractor)

l) Ammonia Scrubber (size to be determined by the Contractor)

m) Carbon Adsorption Column (size to be determined by the Contractor)

n) Air Venting Network (size and configuration to be determined by the Contractor)

Project	BASIN F -RMA	Computed	R. Grachek	Ckd By: BEL
Subject	Pug Mills	Date	3/17/87	Sht. 1 Of #1

ASSUME 100 PCF

P.M. Can Handle 135.8 yd^3/hr

$$\frac{135.8\ yd^3}{hr} \times \frac{27\ ft^3}{yd^3} \times \frac{100\ lb}{ft^3} \times \frac{Ton}{2000\ lb} = 183.3\ TPH$$

SLUDGE

100 PCF
122.2 yd^3/hr
165 TPH

SOIL

110 PCF
48.9 yd^3/hr
72.6 TPH

FLY ASH

75 PCF
13.6 yd^3/hr
13.8 TPH

PRODUCT

101.2 PCF
135.8 yd^3/hr
185.4 TPH

$$\frac{185.4\ Ton}{hr} \times \frac{2000\ lb}{Ton} \times \frac{1\ yd^3}{135.8\ yd^3} \times \frac{yd^3}{27\ ft^3} =$$

Project BASIN F - RMA | Computed R. Grachek Ckd By: BPL
Subject Pilot Test | Date 3/9/87 | Sht. 1 | Of 3

① 72 TPH - McLanahan Mill (Smallest Mill)

Sludge → 100 pcf — Fly Ash → 75 pcf
90% Sludge — 10% Fly Ash ← Const. Volume

Material into pug mill

$0.9(100) + 0.1(75) = 97.5$ pcf

$$\frac{72 \text{ Tons}}{\text{hr}} \times \frac{2000 \text{ lb}}{\text{Ton}} = \underline{144{,}000 \text{ lb/hr}}$$

$$\frac{144{,}000 \text{ lb}}{\text{hr}} \times \frac{\text{ft}^3}{97.5 \text{ lb}} \times \frac{\text{yd}^3}{27 \text{ ft}^3} = 54.7 \text{ yd}^3/\text{hr}$$

$(54.7)(.9) = 49.23 \text{ yd}^3/\text{hr}$ Sludge
$(54.7)(.1) = 5.47 \text{ yd}^3/\text{hr}$ Fly Ash

Assume 14 hrs/day operation

$(49.23)(14) = 689.22 \text{ yd}^3/\text{day}$ Sludge ←
$(5.47)(14) = \underline{76.58 \text{ yd}^3}/\text{day}$ Fly Ash ←

CHEMICAL SUPPLY (fly Ash)

$$\frac{76.58 \text{ yd}^3}{\text{day}} \times \frac{27 \text{ ft}^3}{\text{yd}^3} \times \frac{75 \text{ lb}}{\text{ft}^3} \times \frac{\text{Ton}}{2000 \text{ lb}} \times \frac{\text{Truckload}}{25 \text{ Tons}} \times \frac{5 \text{ days}}{\text{wk}}$$

= 16 Truckloads/wk
in 25 Ton/Load Pneumatic
loading Trucks. ←

② 10 TPH - FEECO mill (Smallest Mill)
90% sludge, 10% fly Ash, Const. Volume
Material into pug mill = 97.5pcf

$$\frac{10 \text{ Tons}}{hr} \times \frac{2000 \text{ lb}}{\text{Ton}} = \frac{20{,}000 \text{ lbs}}{hr}$$

$$\frac{20{,}000 \text{ lb}}{hr} \times \frac{ft^3}{97.5 \text{ lb}} \times \frac{yd^3}{27 ft^3} = 7.6 \, yd^3/hr$$

$(7.6)(.9) = 6.84 \, yd^3/hr$ sludge
$(7.6)(.1) = 0.76 \, yd^3/hr$ fly Ash

Assume 14 hrs/day operation

$(6.84)(14) = 95.76 \, yd^3/day$ sludge ←
$(0.76)(14) = 10.64 \, yd^3/day$ fly Ash ←

CHEMICAL SUPPLY (fly Ash)

$$\frac{10.64 \, yd^3}{day} \times \frac{27 ft^3}{yd^3} \times \frac{75 \text{ lb}}{ft^3} \times \frac{\text{Ton}}{2000 \text{ lb}} \times \frac{\text{Truckload}}{25 \text{ TONS}} \times \frac{5 \text{ days}}{wk}$$

= 2.15 → 3 Truckloads/wk
in 25 Ton/Load Pneumatic ←
loading Trucks.

Project BASIN F - RMA	Computed RWG	Ckd By: BRL
Subject	Date 3/5/87	Sht. 3 Of 3

(3) 160 TPH - McLanahan Mill

Sludge → 100pcf — 90% Sludge
Fly Ash → 75 pcf — 10% Fly Ash ← Const. Volum

Material into pug mill

$$0.9(100) + 0.1(75) = 97.5 \text{ pcf}$$

$$\frac{160 \text{ Ton}}{\text{hr}} \times \frac{2000 \text{ lb}}{\text{Ton}} = \underline{320{,}000 \text{ lb/hr.}}$$

$$\frac{320{,}000 \text{ lb}}{\text{hr}} \times \frac{\text{ft}^3}{97.5 \text{lb}} \times \frac{\text{yd}^3}{27 \text{ft}^3} = 121.56 \text{ yd}^3/\text{hr}$$

$(121.56)(.9) = 109.40 \text{ yd}^3/\text{hr}$ Sludge
$(121.56)(.1) = 12.16 \text{ yd}^3/\text{hr}$ Fly Ash

Assume 14 hrs / day operation

$(109.40)(14) = 1531.62 \text{ yd}^3/\text{day}$ Sludge
$(12.16)(14) = 170.24 \text{ yd}^3/\text{day}$ Fly Ash

Chemical Supply (Fly Ash)

$$\frac{170.24 \text{ yd}^3}{\text{day}} \times \frac{27 \text{ft}^3}{\text{yd}^3} \times \frac{75 \text{lb}}{\text{ft}^3} \times \frac{\text{Ton}}{2000 \text{lb}} \times \frac{\text{Truckload}}{25 \text{Ton}} \times \frac{5 \text{ days}}{\text{wk}}$$

= 35 Truckloads / wk
in 25 Ton / Load Pneumatic
loading Trucks.

Project: BASIN F - RMA | Computed: R. Gracheck | Ckd By: ARL

Subject: [redacted] | Date: [redacted] | Sht. [redacted] 1 of 3

BASIN F - ROCKY MOUNTAIN ARSENAL 3/6/87
ZONE 2 - ORDER OF MAGNITUDE SCREENING
FEECO Dug Mills - STD. SIZES 2 Spaces

TPH @ 60pcf	TPH @ 100pcf	yd³/hr	Selling Price
15	25.00	18.52	$ 20,000
45	75.00	55.56	$ 30,000
110	183.33	135.80	$ 38,000
185	308.34	228.40	$ 51,000
250	416.66	308.64	$ 60,000
325	541.66	401.23	$ 75,000

(A) FULL SCALE OPERATION — ALL UNITS RUNNING (100pcf) + Pilot

ALTERNATIVE				CAP COST / CAP
✓ ①	Pilot	18.52 yd³/hr	→ $ 20,000	→ $1079.91/yd³/hr
	Full	2 - 135.8 yd³/hr	→ $ 76,000	→ $ 279.83/yd³/hr
	TOTALS	290.12 yd³/hr	$ 96,000	→ $330.90/yd³/hr
✓ ②	Pilot	55.56 yd³/hr	→ $ 30,000	→ $539.96/yd³/hr
	Full	2 - 135.8 yd³/hr	→ $ 76,000	→ $279.83/yd³/hr
	TOTALS	327.16 yd³/hr	$106,000	→ $324.00/yd³/hr
③	Pilot	135.80 yd³/hr	→ $ 38,000	→ $279.83/yd³/hr
	Full	228.40 yd³/hr	→ $ 51,000	→ $223.29/yd³/hr
	TOTALS	364.20 yd³/hr	$ 89,000	→ $244.37/yd³/hr
✓ ④	Pilot	18.52 yd³/hr	→ $ 20,000	→ $1079.91/yd³/hr
	Full	308.64 yd³/hr	→ $ 60,000	→ $194.40/yd³/hr
	TOTALS	327.16 yd³/hr	$ 80,000	→ $ 244.52/yd³/hr
✓ ⑤	Pilot	55.56 yd³/hr	→ $ 30,000	→ $539.96/yd³/hr
	Full	228.40 yd³/hr	→ $ 51,000	→ $223.29/yd³/hr
	TOTALS	283.96 yd³/hr	→ $81,000	→ $285.25/yd³/hr
✓ ⑥	Pilot	55.56 yd³/hr	→ $30,000	→ $ 539.96/yd³/hr
	Full	308.64 yd³/hr	→ $ 60,000	→ $ 194.40/yd³/hr
	TOTALS	364.20 yd³/hr	→ $90,000	→ $ 247.12/yd³/hr
✓ ⑦	Pilot	18.52 yd³/hr	→ $20,000	→ $ 1079.91/yd³/hr
	Full	228.40 yd³/hr	→ $51,000	→ $ 223.29/yd³/hr
	TOTALS	246.92 yd³/hr	→ 71,000	→ $ 287.54/yd³/hr
⑧	Pilot+Full	3 - 135.80 yd³/hr	→ $114,000	→ $ 279.83/yd³/hr
	TOTALS	407.40 yd³/hr	→ $114,000	→ $ 279.83/yd³/hr

Project BASIN F - RMA	Computed RDG	Ckd By: BRL
Subject	Date 3/6/87	Sht. 2 Of 3

(B) "PILOT" COSTS - CAPACITIES (100 PCF) (14 hrs/day)

ALTERNATIVE

①④⑦ 18.52 yd^3/hr → $ 20,000 → 260 yd^3/day

②⑤⑥ 55.56 yd^3/hr → $ 30,000 → 778 yd^3/day

③⑧ 135.80 yd^3/hr → $ 38,000 → 1,901 yd^3/day

(C) "FULLSCALE" COSTS - CAPACITIES (100 PCF) (Ranked by Cost) (14 hrs/d

ALTERNATIVE

⑦ 246.92 yd^3/hr → $ 71,000 → 3,457 yd^3/d

④ 327.16 yd^3/hr → $ 80,000 (Δ Cost = $9000) → 4,580 yd^3/d

⑤ 283.96 yd^3/hr → $ 21,000 (Δ Cost = $1000) → 3,975 yd^3/d

③ 364.20 yd^3/hr → $ 89,000 (Δ Cost = $8000) → 5,099 yd^3/d

⑥ 361.20 yd^3/hr → $ 90,000 (Δ Cost = $1000) → 5,099 yd^3/d

① 290.12 yd^3/hr → $ 96,000 (Δ Cost = $6000) → 4,062 yd^3/d

② 327.16 yd^3/hr → $ 106,000 (Δ Cost = $10,000) → 4,580 yd^3/day

⑧ 407.40 yd^3/hr → $ 114,000 (Δ Cost = $8000) → 5,704 yd^3/day

Project BASINF -RMA	Computed RWG	Ckd By: BRL
Subject	Date 3/6/87	Sht. 3 Of 3

① "FULL SCALE" CAPACITIES - w/ one full scale pug mill down.
(Ranked by Capacity)

ALTERNATIVE

④	18.52 yd^3/hr	→	260 yd^3/day
⑦	18.52 yd^3/hr	→	260 yd^3/day
⑤	55.56 yd^3/hr	→	778 yd^3/day
⑥	55.56 yd^3/hr	→	778 yd^3/day
③	135.80 yd^3/hr	→	1,901 yd^3/day
①	154.32 yd^3/hr	→	2,160 yd^3/day
②	191.36 yd^3/hr	→	2,679 yd^3/day
⑧	271.60 yd^3/hr	→	3,802 yd^3/day

Project	Basin F	Computed	R. Grachek	Ckd By	BK
Subject	Chemical Addition	Date	11/8/86	Sht.	1

Assume:

Ammonia Nitrogen = 1000 mg/l
Quantity of Soil in test sample = 100g
SR = 2.0
TWA = 18 mg/m³

Assume PH is raised high Enough to facilitate NH_3 ↑ as in test

$MgSO_4 \cdot 7H_2O$ = 2.98 g

H_3PO_4 = 1.08g

Volume of soil processed / day = 5,000 tons
= 4,545,000 kg

5,000 Tons ÷ 5000 yd³ = 135,000 ft³
= 1,009,500 gallons
= 3,817,004 ℓ
= 3,817 m³

$$\frac{.100\ kg}{.00289\ kg} = \frac{4,545,000\ kg}{X}$$

X = 131,350 kg $MgSO_4 \cdot 7H_2O$ per day

$$\frac{.100\ kg}{.00108\ kg} = \frac{4,545,000\ kg}{X}$$

X = 49,086 kg H_3PO_4 per day

$MgSO_4 \cdot 7H_2O$

$$131,350\ kg \times \frac{1b(2.2)}{kg} \times \frac{ft^3}{62.4(1.5)} = 3087\ ft^3/d$$ Tank 15' Dia 18' high

H_3PO_4 = 98g/mole

Conc H_3PO_4 = 14 molar → 14 moles × 98g/mole = 1372g ÷ 1.372kg

~~$\frac{\ell}{1.372\ kg} \times 49,086\ kg = 35,777\ \ell/d = 1265\ ft^3 =$~~ Tank 10'D

Materials - Basin F [Engr + Const. Mat. Compatibility Study-II

Metals

1. High Carbon Steel
2. Low Carbon Steel
3. 304 Stainless Steel
4. 316 Stainless Steel
5. 2024 Aluminum
6. 6061 Aluminum

} Immersed in "Basin F" waste water and deionized water

Well Screens

1. Stainless Steel } Immersed in "Basin F" wastewater and deionized water
2. PVC } Immersed in well 118 water, 50:50 blend of well 118 + deioni water, and in deionized water

Polymeric Liners

1. Butyl ruboer
2. Chlorinated Polyethylene (CPE)
3. Chlorosulfonated Polyethylene (CSPE)
4. Elastrized Polyolefin (ELPO/3110)
5. Ethylene peopylene rubber (EPDM)
6. High Density polyethelene (HDPE)
7. Low density polyethylene (LDPE)
8. Polyvinyl Chloride (PVC)

Gasket Materials

1. Fluorocerbon elastomer (Viton)
2. Two neoprene compounds
3. Two nitrile rubber compounds
4. Polypropylene
5. Teflon

} Immersed in well 118 water, 50:50 blend of well 118 water & deionized water, and deionized water.

No Analysis was done on Rubber meterials in "Basin F" waters.

PVDF

Results

1. Metals → After 18 months Exposure @ Ambient Temp

A. Weight Change, %

	Deionized	Basin F
High Carbon Steel	−0.1%	−1.5% ←
Low Carbon Steel	−0.6%	−3.6% ←
304 Stainless	0.0%	−1.0% ←
316 Stainless	0.0%	0.0% ←
2024 Aluminum	+0.9%	+ 26.7%
6061 Aluminum	+0.8%	− 3.7%

B. Tensile Strength, % Retention

	Deionized	Basin F
High Carbon Steel (98,200psi)	102%	101% ←
Low Carbon Steel (72,300psi)	104%	101% ←
304 Stainless (81,100psi)	125%	121% ←
316 Stainless (86,100psi)	98%	106% ←
2024 Aluminum (65,900psi)	97%	11%
6061 Aluminum (49,400psi)	96%	4%

C. Elongation, % Retention

	Deionized	Basin F
High Carbon Steel (22%)	102%	101% ←
Low Carbon Steel (13%)	73%	73% ←
304 Stainless (51%)	115%	107% ←
316 Stainless (52%)	95%	99% ←
2024 Aluminum (18%)	74%	No Value (Decomposed)
6061 Aluminum (13%)	96%	12%

D. Yield Strength, % Retention

	Deionized	Basin F
High Carbon Steel (69,400psi)	75%	79% ←
Low Carbon Steel (70,600psi)	105%	102% ←
304 Stainless (58,300psi)	108%	99% ←
316 Stainless (43,100psi)	84%	98% ←
2024 Aluminum (41,200psi)	115%	No Value (Decompose
6061 Aluminum (35,500psi)	122%	5%

E. Hardness, Rockwell B, % retention

	Deionized	Basin F	
High Carbon Steel (87pts)	105%	105%	←
Low Carbon Steel (84pts.)	103%	101%	←
304 Stainless (87pts)	105%	104%	←
316 Stainless (72 pts.)	99%	101%	←
2024 Aluminum (69 pts.)	100%	84%	←
6061 Aluminum (66pts.)	98%	102%	←

ANALYSIS:

Aluminum (2024 or 6061) should not be used in contact with Basin F water. Properties deteriorated quite rapidly

Both the Carbon and Stainless steels appear to be adequate for the intended operation. The decision as to which materials to use should be based on cost considerations. Intended uses include:

- Piping (Suction and Discharge)
- Pumps
- Pump Equipment

RWG 1/87 (4)

Rough Cost Estimates - Pipe (Means)

Steel Pipe (Installed) Sch. 40

6"	$51.00/LF
12"	$110.00/LF

Stainless Steel Pipe (Installed) Sch 10

304 -	6"	$38.00/LF
	12"	$96.00/LF
316 -	6"	$45.00/LF
	12"	$115.00/LF

HDR Internal Memorandum

To Mike Elzway Date 3/23/87

From Tom FURNE Subject BASIN F electrical

I will be needing the following additional electrical rqmts:

230V 1ϕ 60Hz 70 amp (min). for heat tracing on the liquid transfer line.

MCC NO: MCC	480 VOLTS, 3 PHASE, 3 W, 600 AMP/BUS 22 KAIC RATING	PAGE 1 OF 1

MAIN DEVICE:

_____ AMP. M. L. O 600 AMP. FRAME C.B 500 TRIP 25 KAIC RATING

SERVICE ENTRANCE LABEL:	FEEDER SOURCE:	FEEDER SIZE:
Yes	pad-mounted XFMR	__ #_____, 1 #_____ GRND (SEE NOTE 1 & 2)

CKT NO.	CIRCUIT DESCRIPTION	HP	KVA	AMPS	Ø	MS NEMA SIZE	O.C PROTECT MCP/CB	O.C PROTECT FRM/TRP	FEEDER SIZE	MK NO.
	BC-103	7½		11	3					
	Sc-101	2		3.4						
	Bc-106	5		7.6						
	Sc-102	2		3.4						
	Bc-109	5		7.6						
	PM-101	15		21						
	PM-102	75		96						
	PM-103	75		96						
	F-101	10		14						
	F-102	10		14						
	P-103	2		3.4						
	Bc-101	5		7.6						
	Bc-102	5		7.6						
	Bc-104	5		7.6						
	Bc-105	5		7.6						
	Bc-107	5		7.6						
	Bc-108	5		7.6						
	RF-101	3/4		1.4						
	RF-103	3/4		1.4						
	RF-105	3/4		1.4						
	~~XFRM~~ XFRM		30	36	↓					
	TOTAL	242.75	30	366.8						

FEEDER SIZE = AMP X 125% =

HDR Infrastructure
A Centerra Company

NOTES:
1) SELECT GROUND WIRE SIZE FROM NEC TABLE 250-95.
2) IF FEEDER SOURCE IS UTILITY OR PLANT TRANSFORMER; SIZE GROUNDED CONDUCTOR FOR NEC 250-23 AND EQUIPMENT GROUNDING CONDUCTOR FROM NEC TABLE 250-95.

Project: Basin F | Computed: Mike ELzway | Ckd By: BEL
Subject: Electrical Load Estimate | Date: 3-20-87 | Sht. 1 | Of 1

1- Pug Mill process _ motor control center "MCC" connected load

- Total horsepower Load (242.75 HP) ____ 330.6 Amp
* - Dry type Transformer (30 kVA) Misc. loads ____ 36.0 Amp

total 366.6 Amp @ 480 volt

Connected Load in "kVA" = 366.6 x 0.48 kv x $\sqrt{3}$

$\cong$ 305 kVA

Use 300 kVA Transformer rated @ 480 volt Three phase Secondary

* The dry type transformer is rated 480 volt primary, 120/208 volt three phase secondary. The kVA rating is an estimate at this time. we may end-up using 15 kVA rated transformer depending on small Misc. Loads.

2. Pump station:

- Air Compressor (75 HP) @ 480V, 3 ϕ 96 Amps
* - Mini-~~load~~ power Center (10kVA), 1 ϕ 20.8 Amp

Total 116.8 Amp @ 480 volt

Connected Load in "kVA" = 116.8 A x 0.48 kv x $\sqrt{3}$
= 97 kVA

Use 112.5 kVA Transformer rated @ 480 volt Three phase secondary

* May end-up using 5 kVA center depending on Misc. Loads.

Project	BASIN F	Computed	TJF	Ckd By	BRL
Subject	Electrical Design Criteria	Date	3/18/87	Sht.	1 Of

Electrical Rqmts:

Pump Station:

Air Compressor	75 Hp	460V	3 ϕ	60 Hz	
Utility Power	120 VAC				30 amps

Absorption Pad:

Pilot scale -

✓ pug mill PM-101	15 Hp	460 V	3ϕ	60 Hz	
✓ Belt Conveyor, BC-101	5 Hp	"	"	"	(variable speed)
✓ Belt Conveyor, BC-102	5 Hp	"	"	"	(variable speed,
✓ Belt Conveyor, BC-103	7.5 Hp	"	"	"	
Fly Ash Rotary Feeder, RF-101	3/4 Hp	"	"	"	(variable speed)
Portland Cement Rotary Feeder, RF-102	1/4 Hp	120 VAC	1ϕ	60 Hz	(variable speed
✓ Portland Cement Screw Conveyor, SC-101	2 Hp	460 V	3ϕ	60 Hz	
Sulfuric Acid pump, P-101	—	120 VAC	1ϕ	60 Hz	
" " " , P-102	—	120 VAC	1ϕ	60 Hz	
Exhaust Fan, F-101		460 V	3ϕ	60 Hz	
Scrubber Recirc. Pump, P-103	2 Hp	"	"	"	
Exhaust Fan, F-102		"	"	"	

Utility Power: 3(30) amps. 120 V AC

Project	BASIN F	Computed	TJF	Ckd By: BRL
Subject		Date	3/13/87	Sht. 1 Of

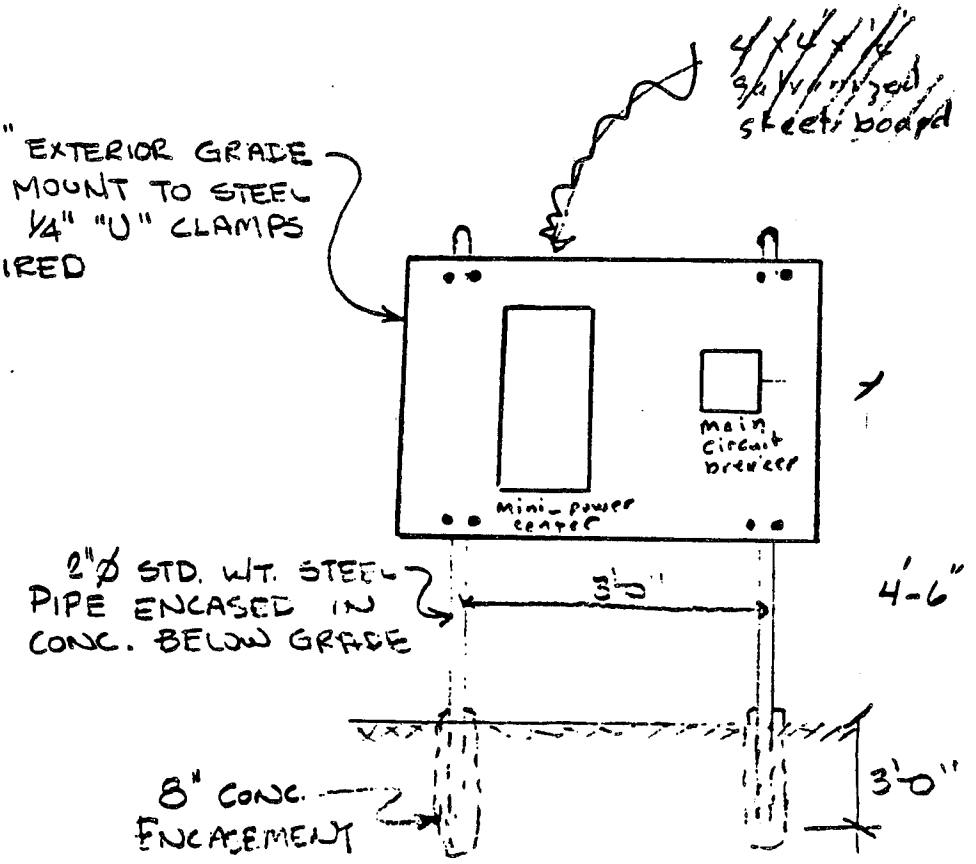
Full scale:

(1)	Belt Conveyor, BC-104	5Hp	460V	3φ	60Hz	(variable speed)
	Belt Conveyor, BC-105	5Hp	"	"	"	(variable speed)
	✓ Pug Mill, PM-102	75Hp	460V	3φ	60Hz	
	✓ Belt Conveyor, BC-106	5Hp	"	"	"	
	Fly Ash Rotary Feeder, RF-103	3/4 Hp	"	"	"	(variable speed)
	Portland Cement Rotary Feeder, RF-104	1/4 Hp	120VAC	1φ	60Hz	(variable speed)
	✓ " " Screw Conveyor, SC-102	2 Hp	460V	3φ	60Hz	
	~~Sulfuric Acid pump, P-103~~	~~120VAC~~		~~1φ~~	~~60Hz~~	
	~~" " , P-105~~	~~"~~		~~"~~	~~"~~	
	~~Exhaust Fan, E-103~~	~~Hp~~	~~460V~~	~~3φ~~	~~60Hz~~	
	~~Exhaust Fan, E-104~~	~~Hp~~	~~460V~~	~~3φ~~	~~60Hz~~	
	~~Scrubber Recirc Pump, P-106~~	~~2Hp~~	~~460V~~	~~3φ~~	~~60Hz~~	

(2)	Belt Conveyor, BC-107	5Hp	460V	3φ	60Hz	(variable speed)
	Belt Conveyor, BC-108	"	"	"	"	"
	✓ Pug Mill, PM-102	75Hp	"	"	"	
	✓ Belt Conveyor, BC-109	5Hp	"	"	"	
	Fly Ash Rotary Feeder, RF-105	3/4Hp	"	"	"	(variable speed)
	Portland Cement Rotary Feeder, RF-106	1/4Hp	120VAC	1φ	60Hz	" "
	✓ " " Screw Conveyor, SC-103	2Hp	460V	3φ	60Hz	
	~~Sulfuric Acid pump, P-107~~					
	~~" " , P-108~~					
	~~Exhaust Fan, E-105~~					
	~~Exhaust Fan, E-~~					

Note:
1. All motors will have local disconnects
They will be weather-proof.
They should have pilot lights.
2. All motor starters will have HOA's on them
3. In MCC, include extra panel for a control panel.
4. MCC shall be weather-proof

Project	BASIN F	Computed	Chk by EWG
Subject	Electrical	Date 3/87	Sht. / Of



Pump station service-mounting detail

N/O Scale

Mike Elgas

Chk by Rao

PANEL: "LP" circuit schedule	ENTRANCE: TOP/BOTTOM	MOUNTING: ~~SURFACE/FLUSH~~ MCC
SERVICE: 120/208 VOLTS, 3 PHASE, 4 WIRE, 100% NEUTRAL		SERVICE ENTRANCE LABEL: ~~YES~~/NO
MAIN DEVICE: AMP M.L.O. 100 AMP CIRCUIT BREAKER, 3 POLE, 10 KAIC INTERRUPTING RATING		
FEEDER SOURCE: 30 kva Transformer	FEEDER SIZE responsibility of mcc supplier	

CKT. NO.	CIRCUIT IDENTIFICATION	C.B. AMPS.	WATTS PER PHASE A	B	C	C.B. AMPS	CIRCUIT IDENTIFICATION	CKT. NO.
1	Lights	20/1				20/1	VSD - 110	2
3	Lights	20/1				20/1	VSD - 111	4
5	Receptacles	20/1				20/1	VSD - 112	6
7	Receptacles	20/1				20/1		8
9	Receptacles	20/1				20/1		10
11		20/1				20/1		12
13		20/1				20/1		14
15		20/1				20/1		16
17		20/1				20/1		18
19		20/1				20/1		20
21	space	↓				↓	space	22
23	space	↓				↓	space	24
25								26
27								28
29								30
31								32
33								34
35								36
37								38
39								40
41								42

Chk by RJG

PANEL: Mini - Power Center Panel	ENTRANCE: TOP / BOTTOM	MOUNTING: SURFACE ~~FLUSH~~
SERVICE: 120/240 VOLTS, 1 PHASE, 3 WIRE, 100% NEUTRAL		SERVICE ENTRANCE LABEL: ~~YES~~ NO
MAIN DEVICE: AMP M.L.O. 50 AMP CIRCUIT BREAKER, 2 POLE, 10 KAIC INTERRUPTING RATING		
FEEDER SOURCE: 10 kVA Transformer	FEEDER SIZE	

CKT. NO.	CIRCUIT IDENTIFICATION	C.B. AMPS.	WATTS PER PHASE A	WATTS PER PHASE B	WATTS PER PHASE C	C.B. AMPS	CIRCUIT IDENTIFICATION	CKT. NO.
1	Lights	20/1				20/1		2
3	Receptacles	20/1				20/1		4
5		20/1				20/1		6
7		20/1				20/1		8
9								10
11								12
13								14
15								16
17								18
19								20
21								22
23								24
25								26
27								28
29								30
31								32
33								34
35								36
37								38
39								40
41								42

Chk for EWG

CIRCUIT SCHEDULE

MARK	Ø CONDUCTORS	GROUND CONDUCTOR	CONDUIT SIZE
EQUIPMENT FEEDERS			
1	3 - #12	1 - #12	3/4"
2	3 - #10	1 - #10	3/4"
3	4 - #10	1 - #10	3/4"
4	3 - #8	1 - #10	1"
5	4 - #8	1 - #10	1"
6	3 - #6	1 - #8	1"
7	3 - #4	1 - #8	1 - 1/4"
8	3 - #3	1 - #8	1 - 1/4"
9	4 - #3	1 - #8	1 - 1/4"
10	3 - #2	1 - #6	1 - 1/2"
11	3 - #1	1 - #6	1 - 1/2"
12	3 - #1/0	1 - #6	2"
13	4 - #1/0	1 - #6	2"
14	3 - #2/0	1 - #6	2"
15	3 - #3/0	1 - #4	2"
16	3 - #4/0	1 - #4	2 - 1/2"
17	3 - #250	1 - #4	3"
18	4 - #250	1 - #4	3"
19	4 - #350	1 - #3	31/2"
20	3 - #500	1 - #3	3 - 1/2"
21			
22			
23			
24			

MARK	Ø CONDUCTORS	GROUND CONDUCTOR	CONDUIT SIZE
SERVICE FEEDERS			
25	3 - #4/0	1 - #2	2 - 1/2"
26	2 - (3 - #4/0)	2 - (1 - #1/0)	2 - (2 -1/2")
27	3 - #350	1 - #2	3"
28	2 - (3 - #350)	2 - (1 - #2/0)	2 - 3"
29	3 - #500	1 - #1/0	3 - 1/2"
30	2 - (3 - #500)	2 - (1 - #2/0)	2 - (3 -1/2")
31	3 - (3 - #500)	3 - (1 - #250)	3 - (3 -1/2")
32	4 - (3 - #500)	4 - (1 - #250)	4 - (3 -1/2")
33			
34			
35			
	CONTROL CIRCUIT		
40	2 - #14	IN SAME CONDUIT WITH OTHER CONDUCTORS. IN 1/2" CONDUIT IF MARK NO. APPEARS ALONE.	
41	3 - #14		
42	4 - #14		
43	6 - #14		
44			
45			
46			
47			
	INSTRUMENTATION CIRCUIT		
50	1 - #18 TSP,3/4" C		

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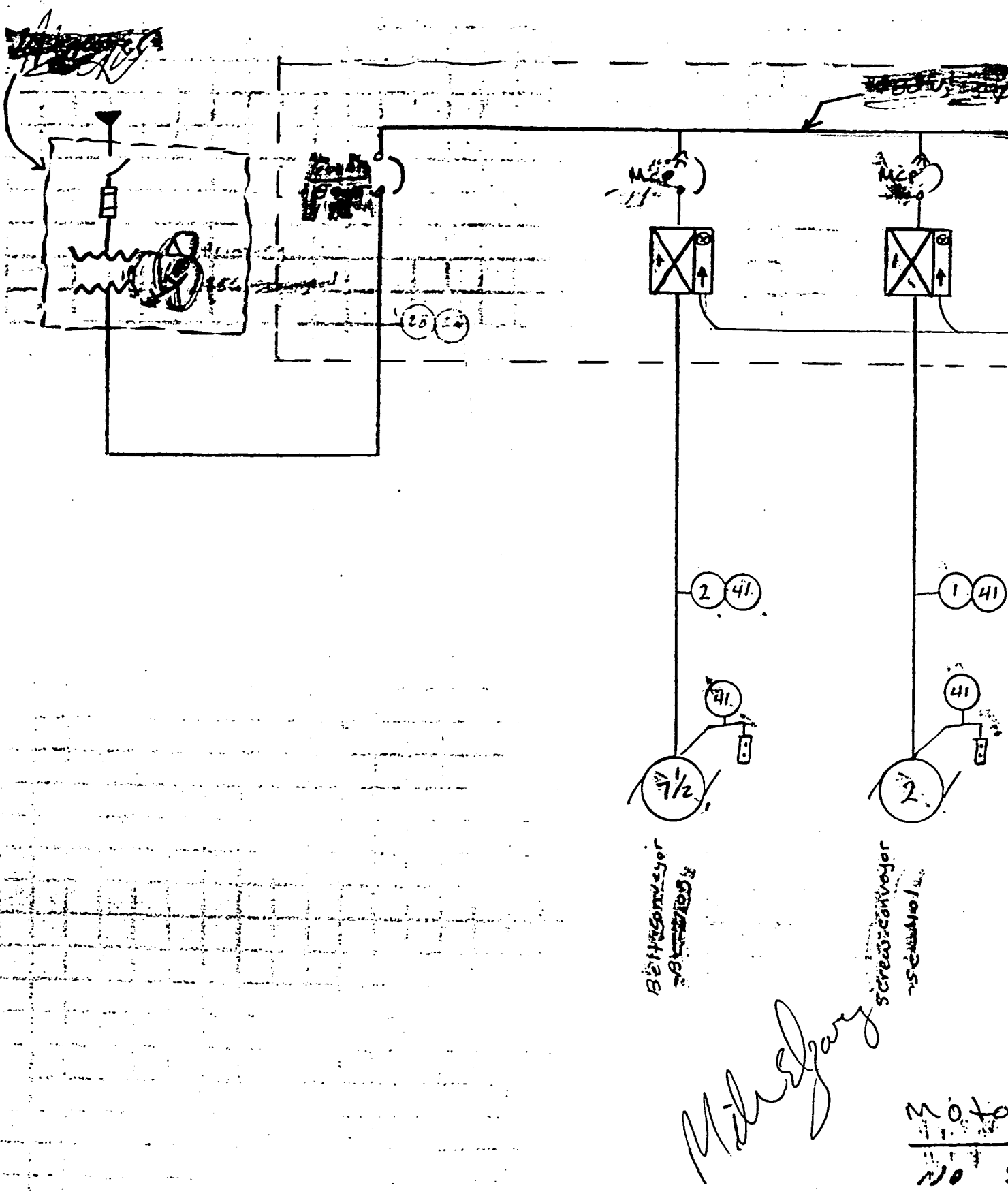
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Mike Elsaway

DR

Project _____ Computed _____

Subject _____ Date _____

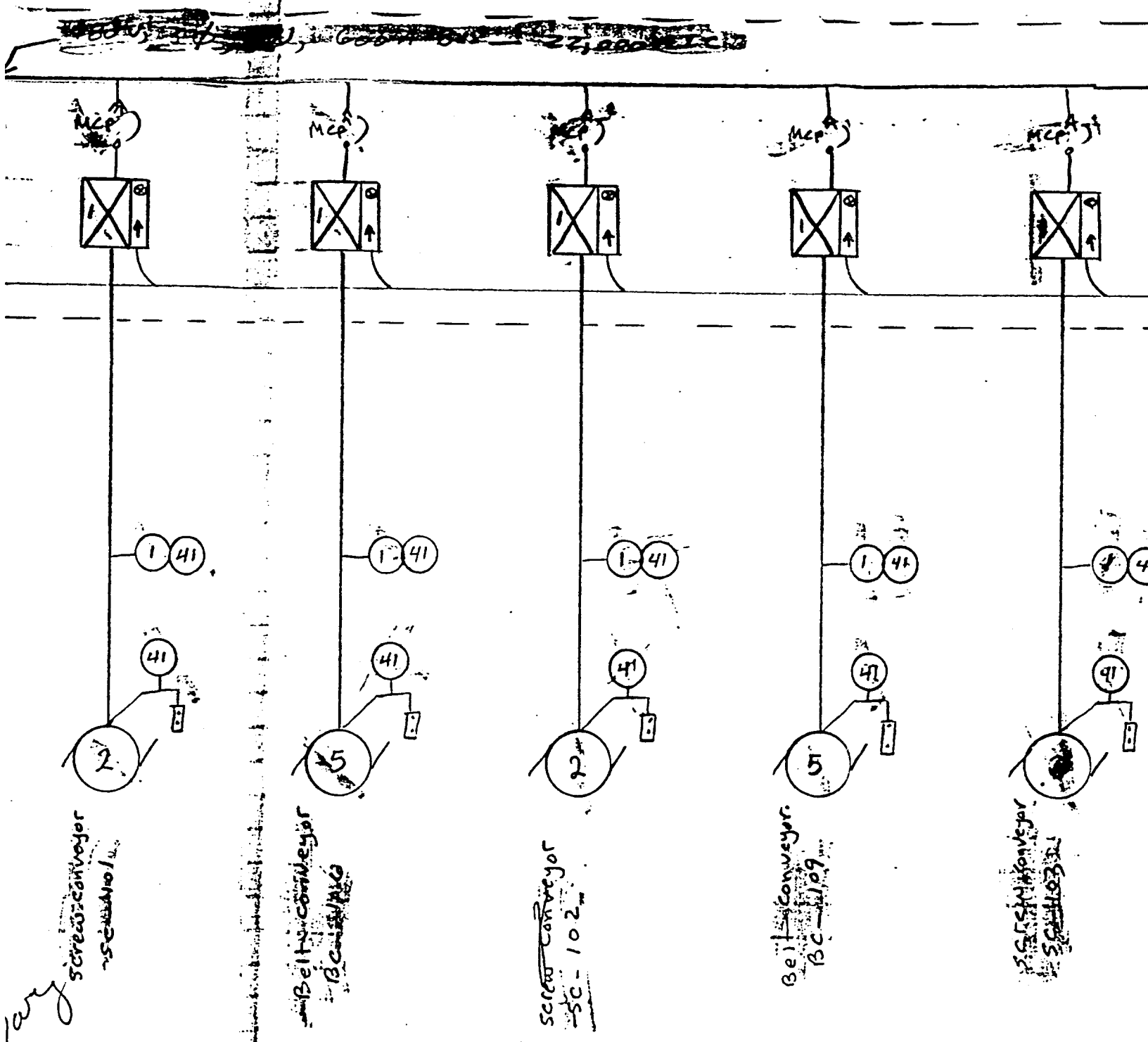


(1)

Chk by RWG

d

Date Sht. Of



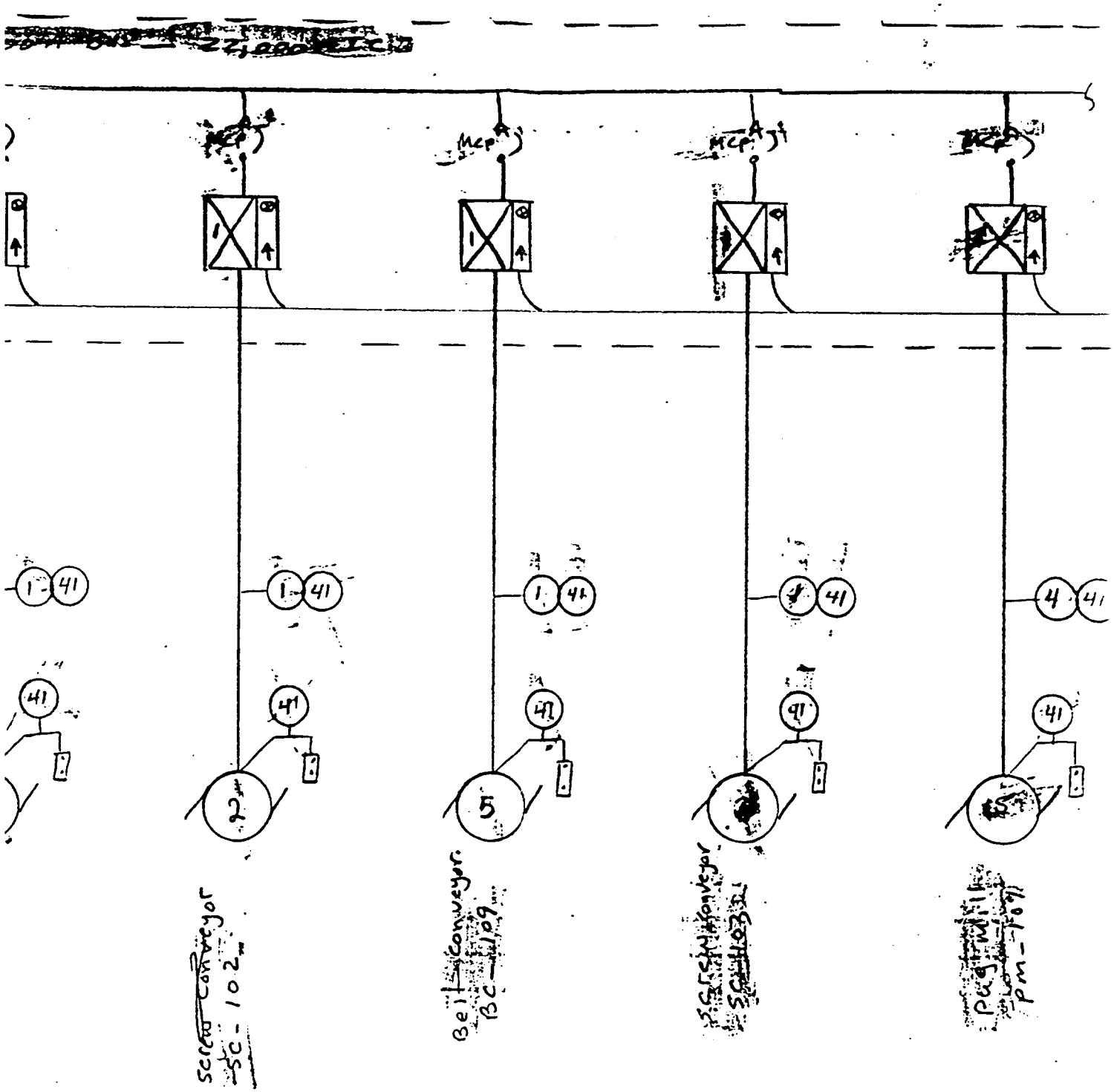
Motor control center "MCC" One Line diagram

No Scale.

k by RJG

_____

_____ of _____

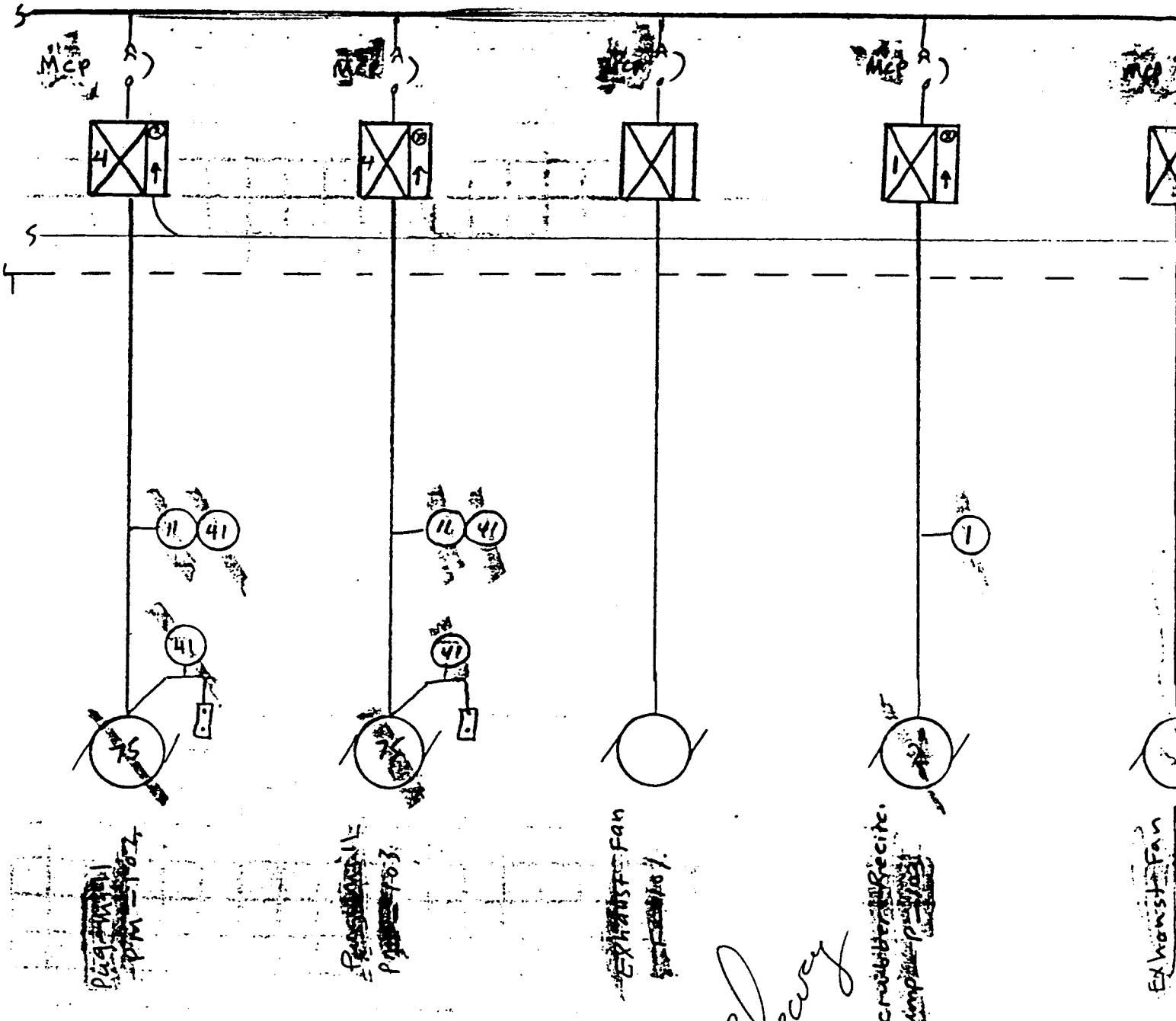


ol. center "MCC" One Line diagram)

Chk by RWG (2)

Project _____ Computed _____

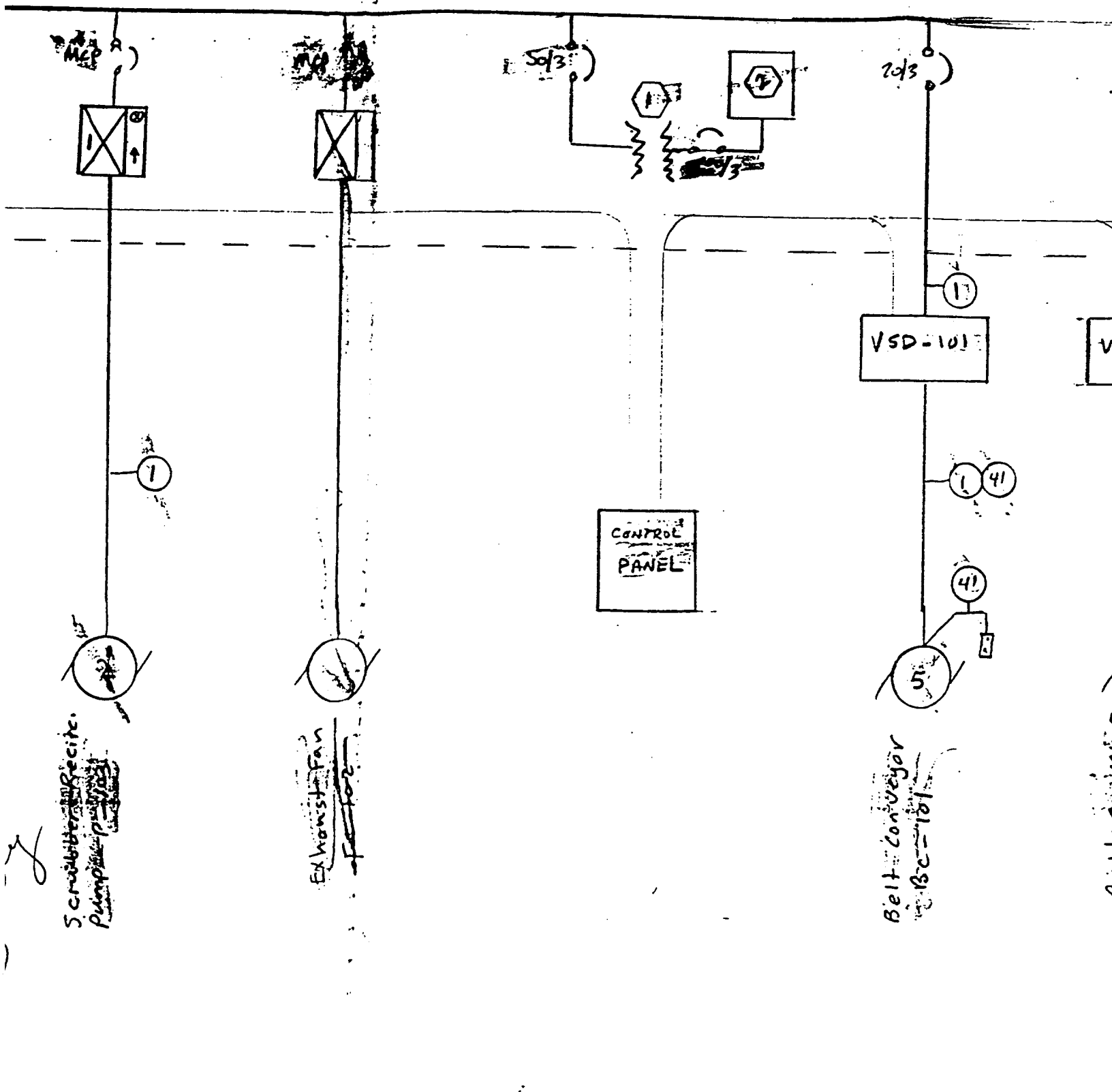
Subject _____ Date _____

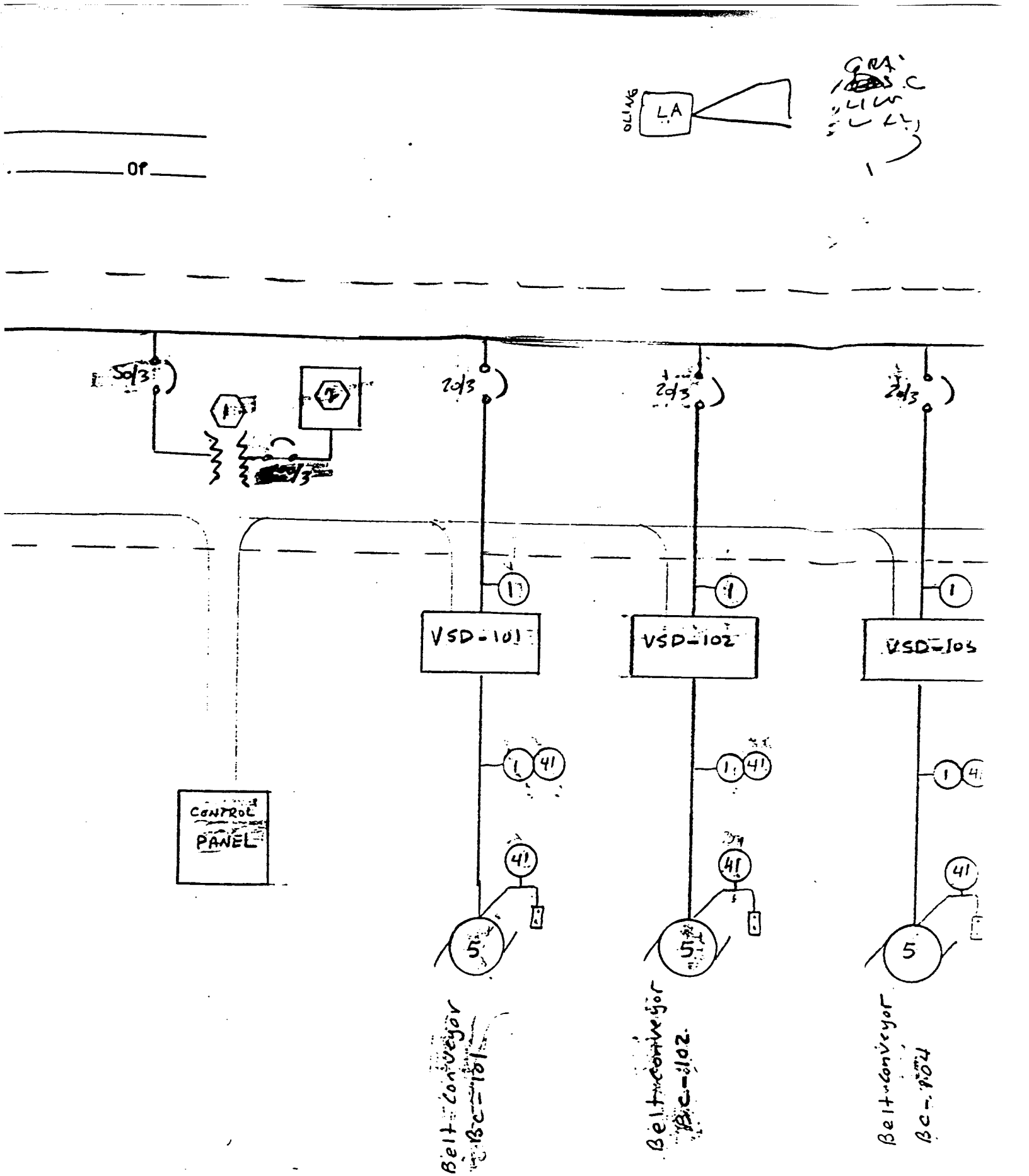


Chk by RWG (2)

Computed

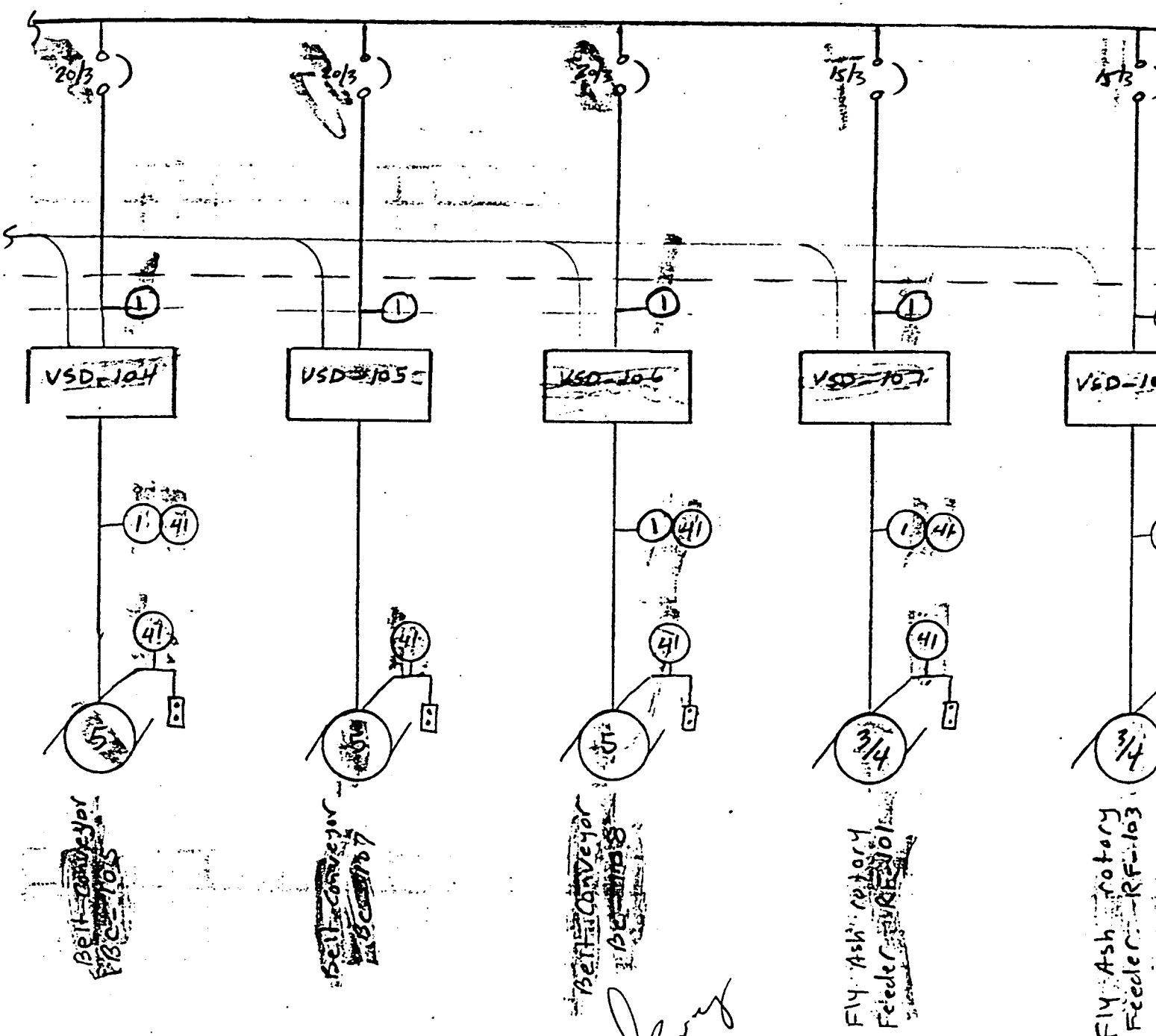
Date Sht. Of




LA
50/3
2o/3
2o/3
2o/3
VSD-101
VSD-102
VSD-103
CONTROL
PANEL
Belt Conveyor
BC-101
Belt conveyor
BC-102
Belt Conveyor
BC-103

Project _____ Computed _____

Subject _____ Date _____

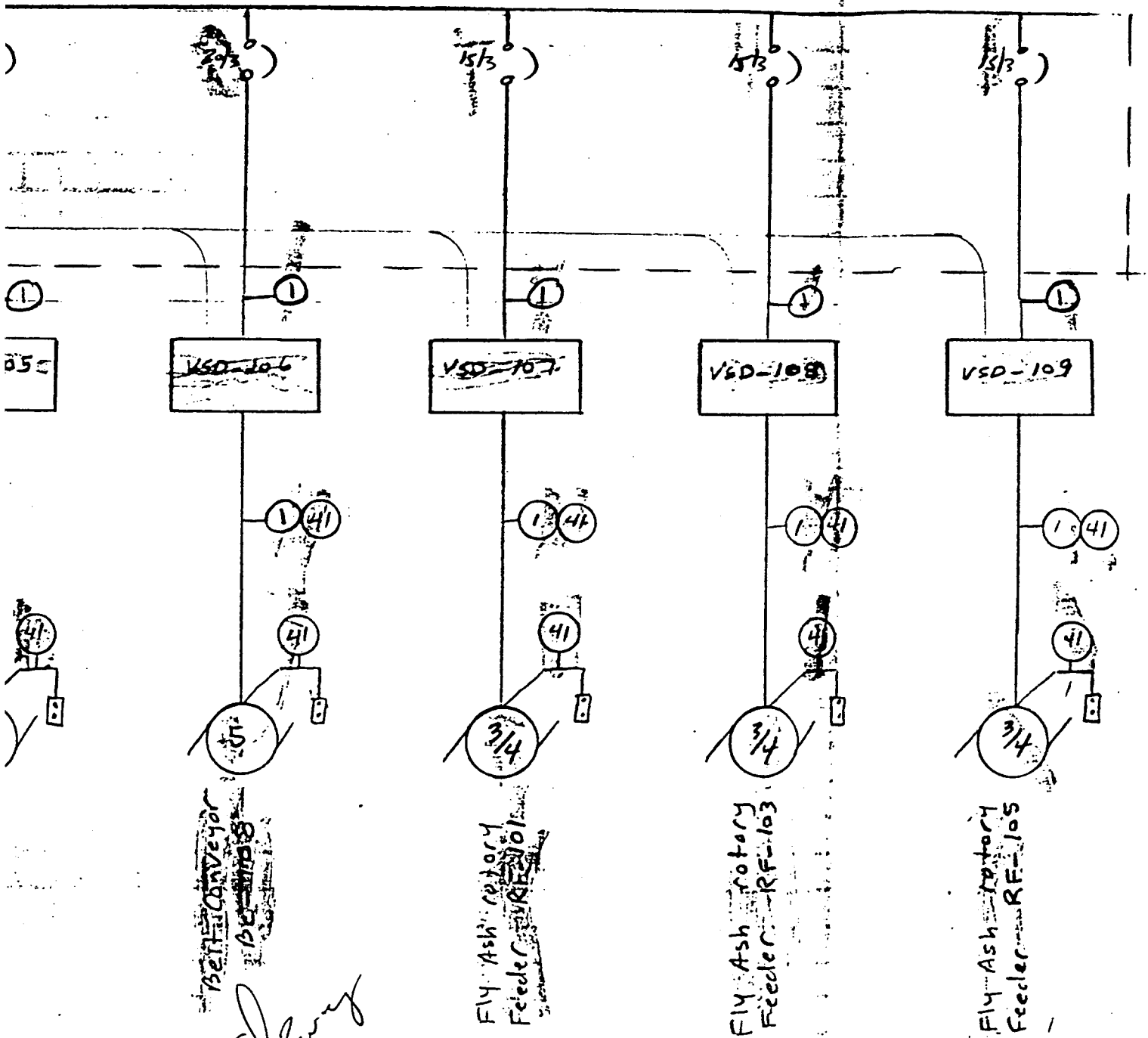


(3)

Chk by ewg

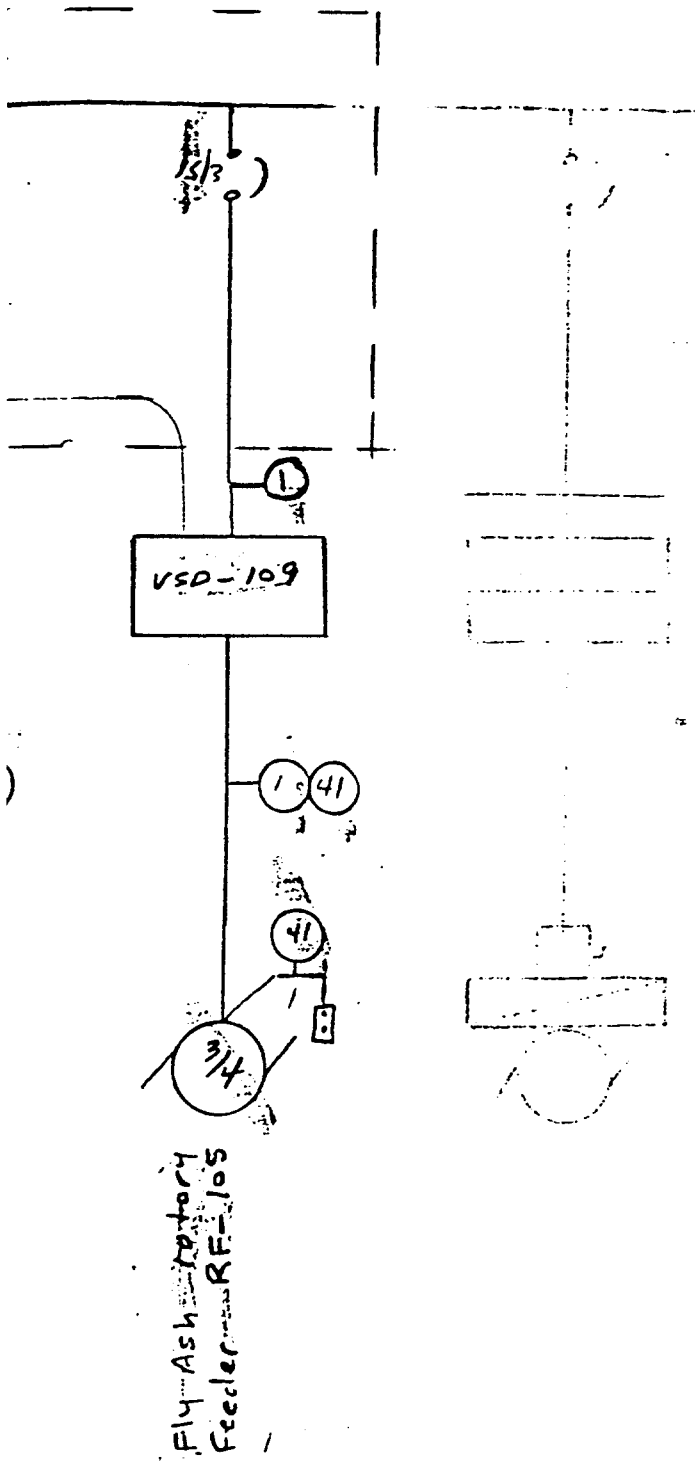
Computed

Date Sht. Of



Chk by EWG

ht. _____ Of _____



NOTES

(1) Dry Type Transformer: 30 kVA, 480V - 120/208V, 3 ϕ.

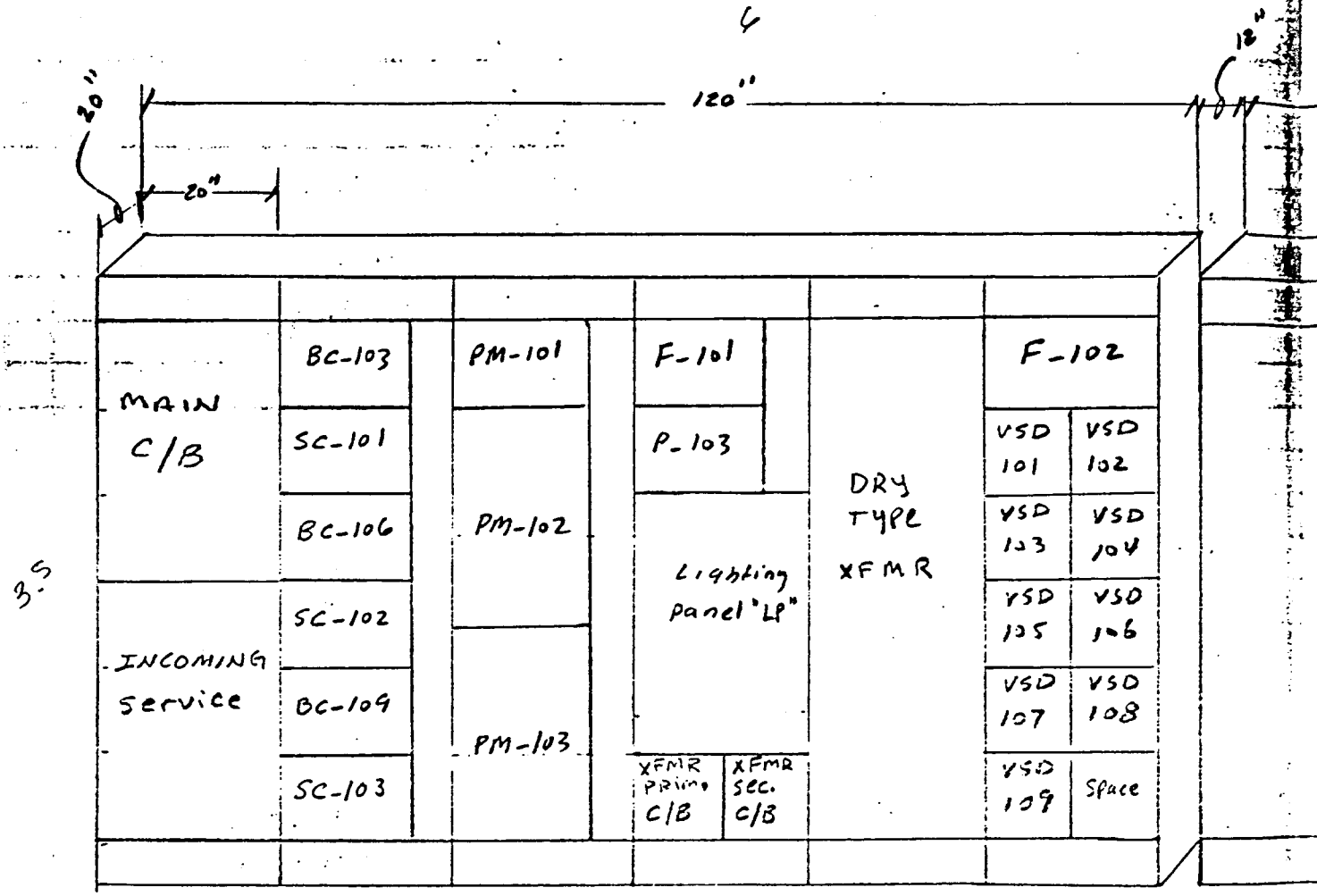
(2) Lighting panel, "LP". See Panel Schedule.

Chk by RWA

(4)

Project _____ Computed _____

Subject _____ Date _____

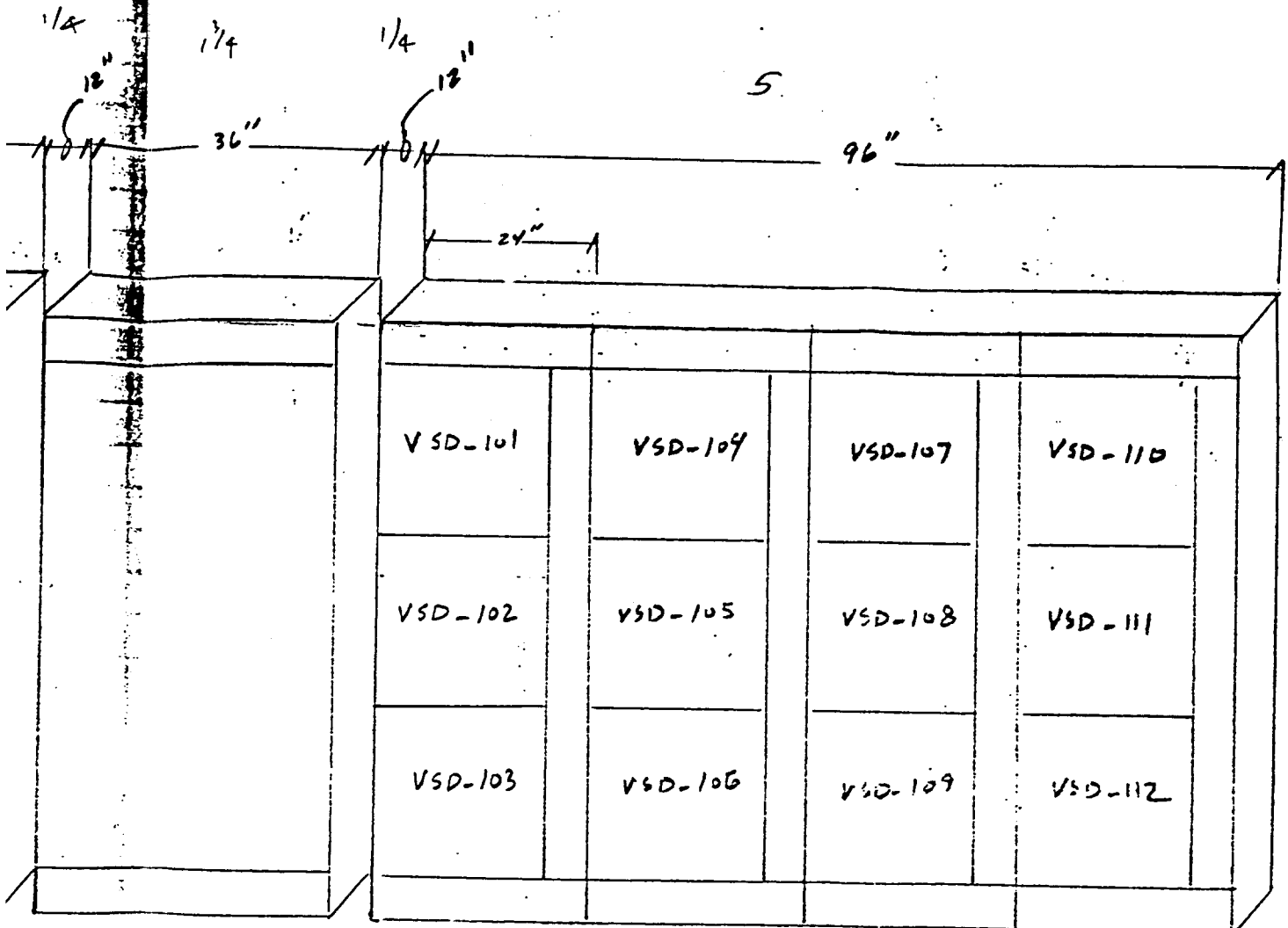


Motor control center "MCC"

ELEVATION — NO scale

(4)

Sht. _____ Of _____



CONTROL PANEL

ELEVATION — NO SCALE

VARIABLE SPEED DRIVES

ELEVATION — NO SCALE

Serpentix ...
The Only Belt Conveyor That Can Ca[illegible] in A Continuous, 3-Dimensional Path.

Operating over a continuous, three-dimensional path, Serpentix easily out performs — at *less* cost — conventional conveyors which can only operate along a straight line.

The ability to incline and decline steeply and to make continuous horizontal, helical and vertical curves, permits a single Serpentix conveyor to replace multiple conventional conveying devices, eliminating troublesome transfer points and reducing energy, space and maintenance costs.

Its convoluted belt can transport material, regardless of consistency, flowability and size, on an open conveying surface that can curve in every plane.

The Serpentix Belt

The conveyor belt, common to all Serpentix models is made of separate sections (belt pans), which are bolted together to form a watertight surface. Each belt pan has a permanently molded 1½-inch high rubber convolution. Steel stiffeners molded into each pan impart a permanent 20-degree troughing angle to both belt edges.

The convolutions permit the belt to follow horizontal and helical turns by allowing the inner side of the belt to compress and the outer side to expand. As the belt passes over the discharge terminal it is stretched flat. Dry material will fall naturally from the flattened surface. Sticky material can be scraped from the belt.

The combination of convolutions and troughed sides permit transporting material ranging from near liquids to large irregular solids up steep inclines.

The Serpentix Chain

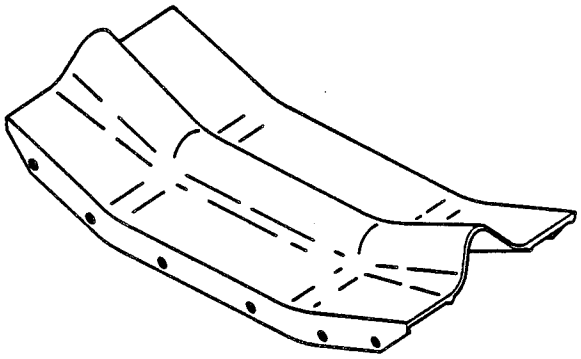
Two types of chain are used to pull Serpentix conveyor belts. A hardened, dual-flex chain is used for the Model I and an all-welded, case-hardened link chain is used on the Model H.

The Model I chain attaches to and is pulled by a drive sprocket through a U.H.M.W. Ultra-high molecular weight polyethylene guide channel.

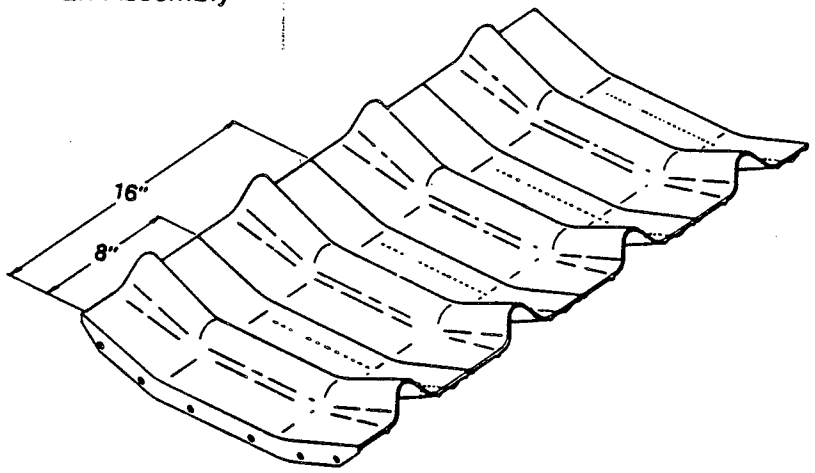
This chain/guide channel combination provides constant, positive tracking and maximum flexibility.

The Model H chain supports and pulls the belt. Every second link of the chain attaches to the underside of the belt pans where the steel stiffeners meet. The chain is supported by roller carriages which track in channel rails to maintain positive horizontal and vertical direction. The Model H comes with either 14mm or 19mm chain, both having a 100mm pitch. (4" Nom.)

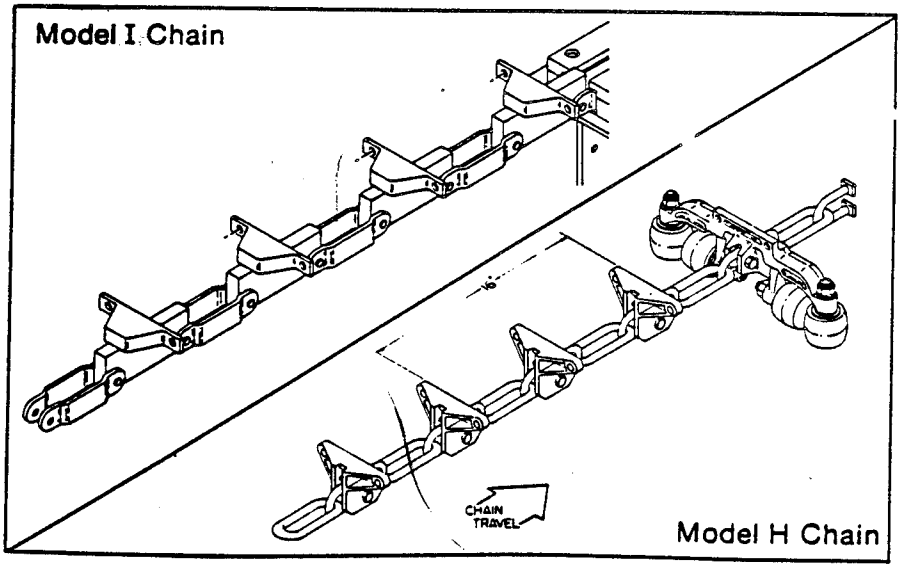
Belt Pan Section



Belt Pan Assembly



Model I Chain



Model H Chain

The Model H

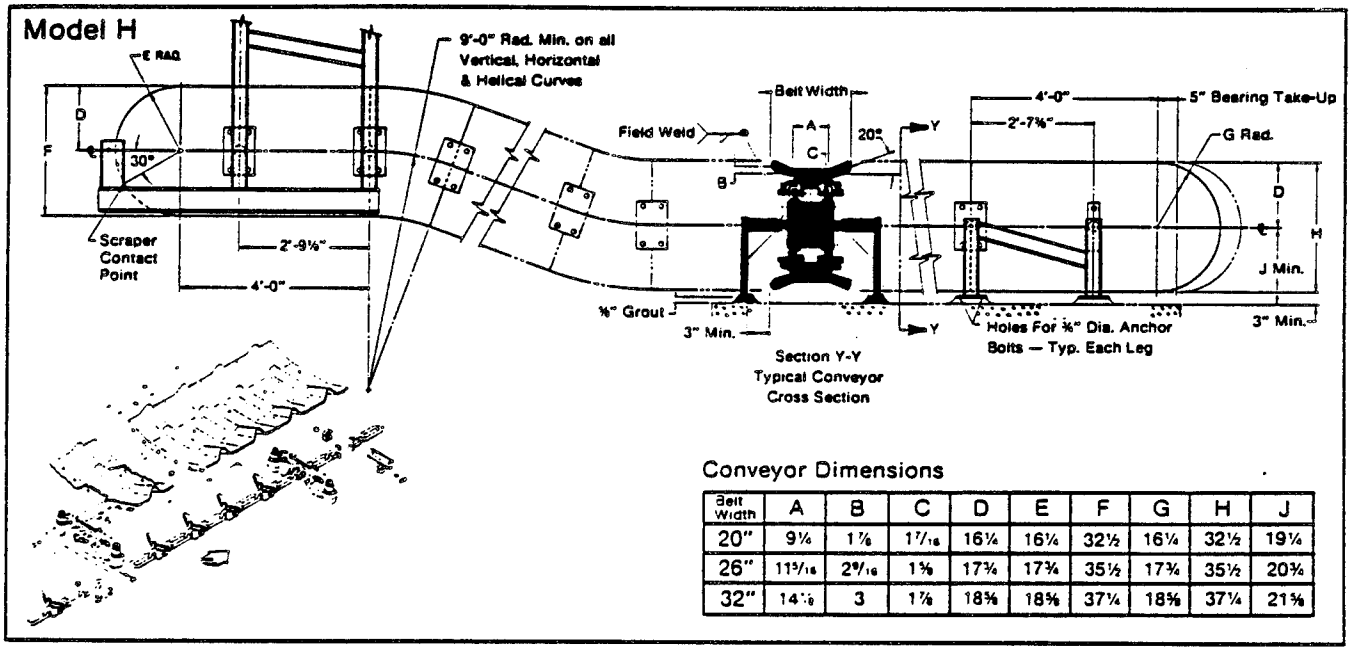
The Model H Serpentix conveyor is designed to convey loads of up to 400 tons per hour (TPH), at belt speeds up to 100 feet per minute (FPM). Belt pan widths are 20", 26", 32" and 40".

Positive belt guidance and tracking are accomplished by attaching the belt to evenly spaced roller carriages that are pulled through a channel track by a steel link chain. The chain, driven by a sprocket at the drive/discharge end, is tensioned by a spring loaded sprocket at the opposite end.

The Model I

The Model I Serpentix coveyor is designed to convey loads of up to 30 tons per hour (TPH), at belt speeds up to 50 feet per minute (FPM). Belt pan widths are 20" and 26". Positive guidance and tracking are accomplished by bolting the belt to attachments welded to a dual-flex chain. The chain is pulled through a guide channel made of U.H.M.W. polyethylene which is bolted to the top and bottom of a fabricated I-beam structure. The chain is pulled by a sprocket at the drive-discharge end. Chain slack is taken up with a manually adjusted take-up sprocket at the opposite end.

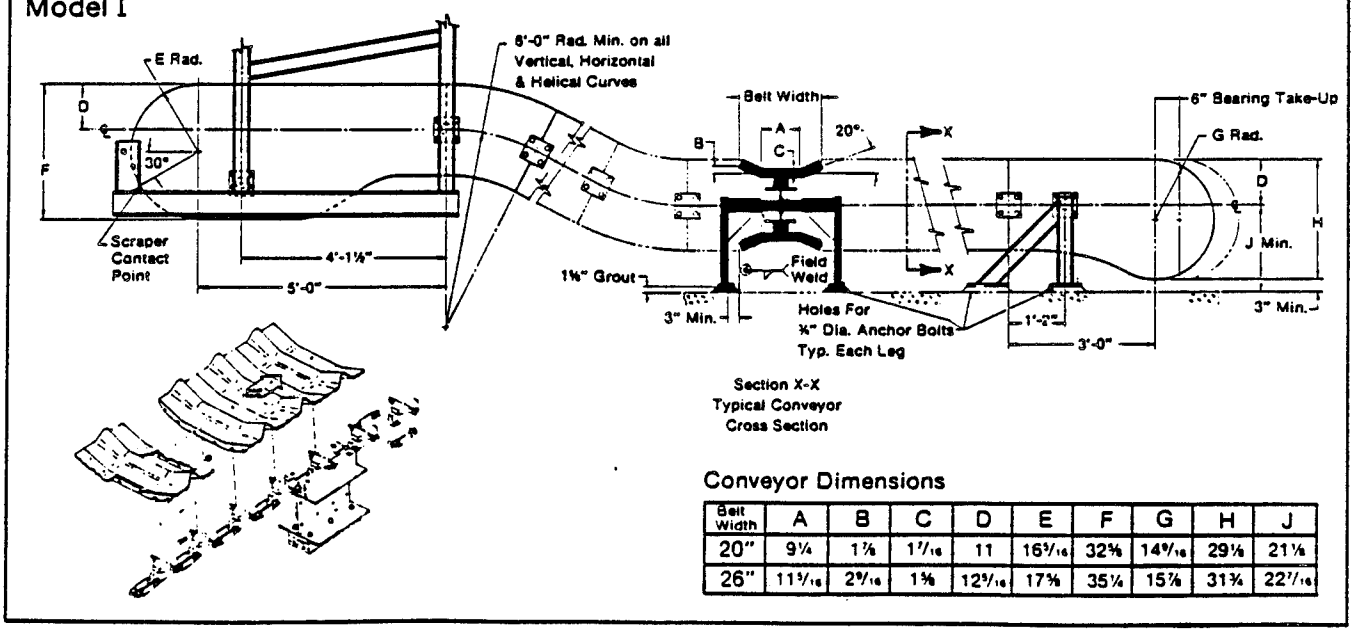
Model H



Conveyor Dimensions

Belt Width	A	B	C	D	E	F	G	H	J
20"	9¼	1⅞	1 7/16	16¼	16¼	32½	16¼	32½	19¼
26"	11 5/16	2 9/16	1⅞	17¾	17¾	35½	17¾	35½	20⅜
32"	14 1/16	3	1⅞	18⅝	18⅝	37¼	18⅝	37¼	21⅝

Model I



Conveyor Dimensions

Belt Width	A	B	C	D	E	F	G	H	J
20"	9¼	1⅞	1 7/16	11	16 5/16	32⅝	14 9/16	29⅛	21⅛
26"	11 5/16	2 9/16	1⅞	12 9/16	17⅝	35¼	15⅞	31¾	22 7/16

Belt Capacities/Features

Serpentix — Carry Materials Of All Consistencies

Representative Flow Characteristics				
	Very Free Flowing	Free Flowing	Average Flowing	Sluggish
Type of Material	Dry Sand Sludge 8–10% Dry Solids	Whole Grain Beans Sludge 9–12% Dry Solids	Coal Rock Gravel Sludge 15–18% Dry Solids	Woodchips Wet Sands Sludge Above 18% Dry Solids

Serpentix — Can Carry Materials Of All Consistencies Up Steep Angles

Suggested Maximum Angle Of Incline				
Angle of Incline	20°	30°	40°	45°

Serpentix — Comes In Two Models And Four Belt Widths

Model "I" Belt Capacity At 30 FPM In Cubic Feet Per Hour				
20" Belt	194	294	460	490
26" Belt	252	378	590	630
Model "H" Belt Capacity At 50 FPM In Cubic Feet Per Hour				
20" Belt	324	486	756	810
26" Belt	421	631	982	1053
32" Belt	640	882	1300	1460
40" Belt	832	1100	1700	1900

Serpentix Features

Length, horsepower and path (with minimum radius of 9'-0" on the Model "H" and 6' on the Model "I") are designed specifically for your application from a complete selection of standard components

Continuous Conveying Surface
• No intermediate transfer points • Handles friable materials gently • Applicable to convey explosives because convolutions limit the spreading of a spontaneous explosion somewhere on the belt

Avoids Obstructions
• Continuous, horizontal, vertical and helical turns • Minimum radii 6' • Conveying surface remains level on helical turns • Serpentix is designed normally to receive and to discharge on the horizontal, regardless of intermediate changes in direction

Elevates Product At Steep Inclines
• Convoluted belt elevates most material at angles of incline over twice as steep as on conventional flat or troughed belt • Serpentix can function as combination bucket elevator by attaching plates or pockets • Free-flowing materials can be conveyed at inclines up to 75° • Shorten building dimensions through more efficient use of space

Belts Can Be Cleaned
• Folds flatten as belt goes over terminals, permitting scraping or brushing • Return side never in contact with stationary idlers, which eliminates idler failure and maintenance

Single Drive Per Serpentix
• Uses less power than conventional system with multiple drives • Eliminates the need for complex electrical interlocking

Power Transmitted By Chain
• No pull on conveying surface • Chain not exposed to material conveyed • Special chains designed for maximum life

Bolted Belt Pans Make Up Surface
• Conveying surface is watertight, no leakage • 20 troughed cross section imparted by steel stiffeners in each pan • Troughing idlers not required • Possible damage to conveying surface limited to individually replaceable pans, preventing loss of entire belt

Belt Convolutions Are at 8" Intervals
• Convolutions permit conveying surface to turn; act like flites, so that products can be conveyed at steep inclines • Permanently molded convolutions flatten out over end terminals, permitting belt cleaning • Convolutions tend to distribute oncoming material such as filtercake for more even distribution on conveying surface

Accessible for Maintenance
• All moving parts return to one point of conveyor which can be selected as servicing station • There are no stationary parts required along the conveyor for servicing

Serpentix Always In Alignment
• Belt is moved and guided through fixed guide channels • Cannot drift • Perfect tracking at all speeds

Oversized Structural Shapes
• Conveyor is self-supporting up to 20' straight spans • Less clutter on operating floor because Serpentix requires fewer supports

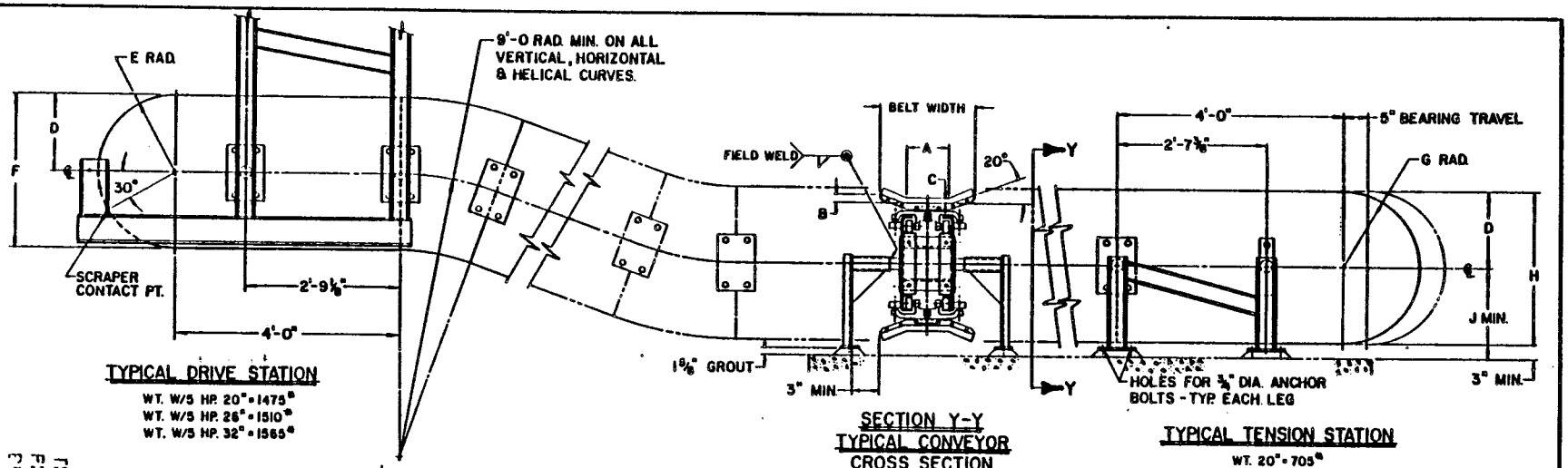
Simple Chain Take-Up
• Only 4" of tension station movement normally is required for the average conveyor • Minimum space required between tail station and an obstruction

Safe For Personnel
• Moving parts other than belt are recessed beneath conveying surface edge • All-flexible belt surface has no sharp edges • Drive guards to meet OSHA requirements

Multiple Uses Possible
• Serpentix can jog to accumulate • Move slowly to cool material • Most Serpentix units can reverse • Conveying surface can tilt to side to make intermediate discharge without requiring termination of conveyor • Flexible ends permit multiple end discharges and/or product loading

Reuse of Serpentix
• Modular construction permits relocation of sections and rerouting of path • Additions or subtractions to conveyor can be made at any time

Features for Wastewater Industry
• Conveys most wet sludges at steeper inclines than any other belt conveyor • Return run can be rolled over to eliminate need for drip pan under conveyor except near terminal • Sticky sludge can be scraped from belt — up to 99% on first pass over discharge terminal



TYPICAL DRIVE STATION

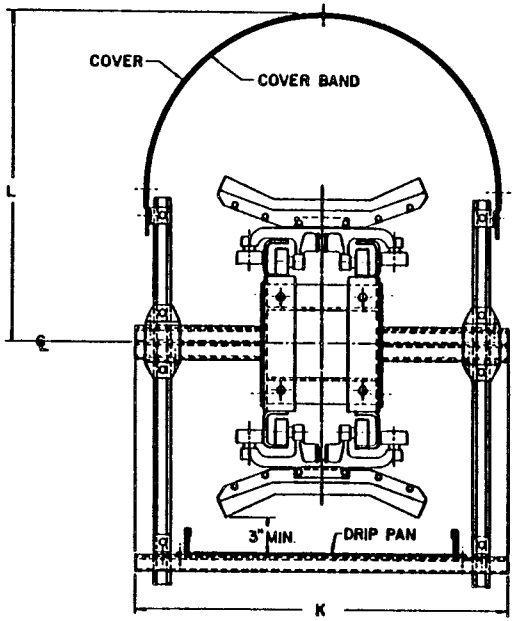
WT. W/5 HP. 20" = 1475#
WT. W/5 HP. 26" = 1510#
WT. W/5 HP. 32" = 1565#

SECTION Y-Y
TYPICAL CONVEYOR
CROSS SECTION

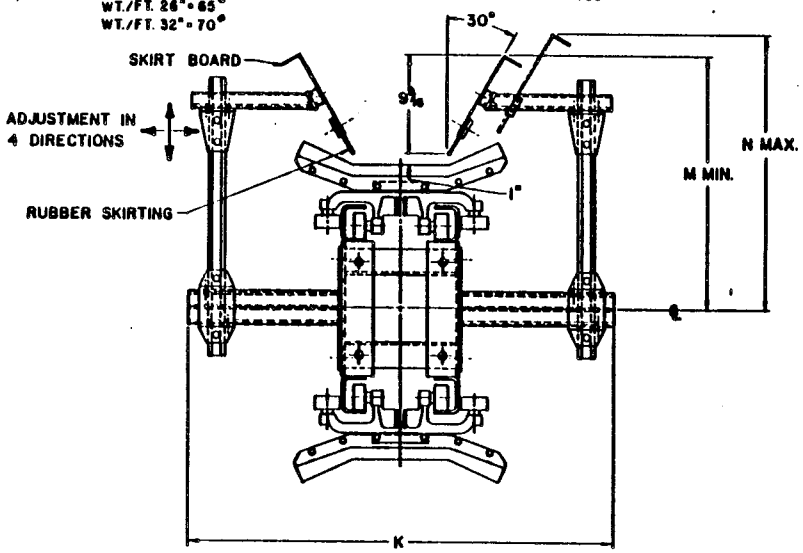
WT./FT. 20" = 60#
WT./FT. 26" = 65#
WT./FT. 32" = 70#

TYPICAL TENSION STATION

WT. 20" = 705#
WT. 26" = 740#
WT. 32" = 795#



TYPICAL DRIP PAN AND COVER CROSS SECTION



TYPICAL SKIRT BOARD CROSS SECTION

CONVEYOR DIMENSIONS

BELT WIDTH	A	B	C	D	E	F	G	H	J	K	L	M	N
20"	9¼	1⅞	1 11/16	16¼	16¼	32½	16¼	32½	19¼	47⅞	30	24 5/16	26 5/16
26"	11 5/16	2⅜	1⅝	17¾	17¾	35½	17¾	35½	20¾	47⅞	30	25⅛	28 5/16
32"	14⅛	3	1⅞	18⅝	18⅝	37¼	18⅝	37¼	21⅝	47⅝	30	25 7/16	29 5/16

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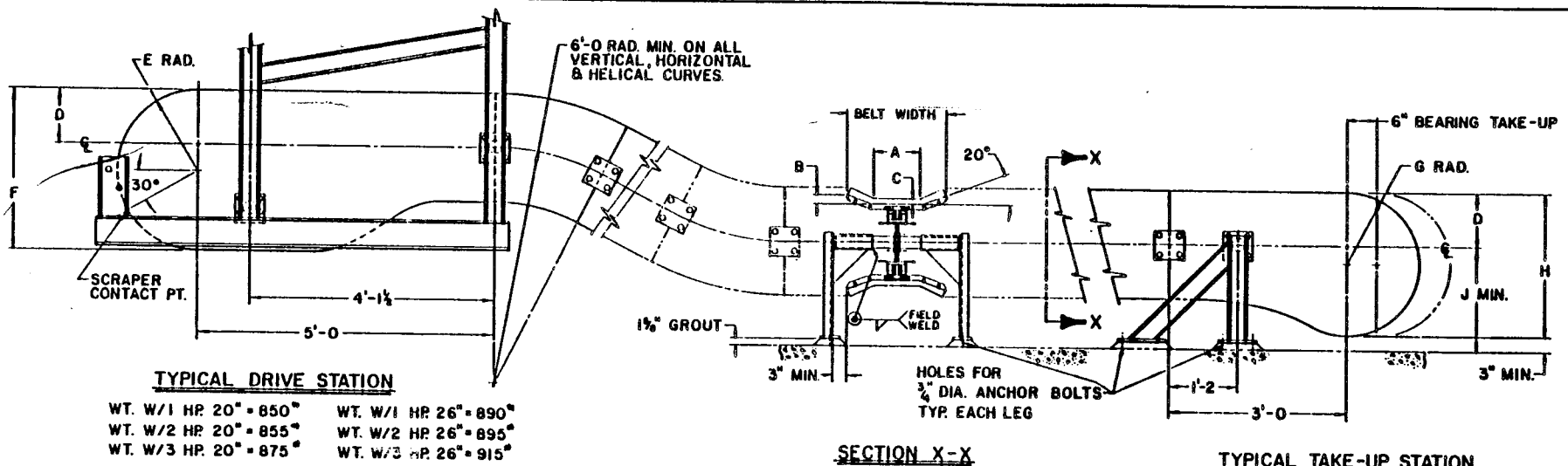
MAR 19 1987

SEC 20, PAGE 1, DATE 12/1/86, REV

TITLE
MODEL H CONVEYOR
STANDARD CROSS SECTIONS

SERPENTIX CONVEYOR CORP.
WESTMINSTER, CO. 80030

DRAWING NO. I-0148-002-C



TYPICAL DRIVE STATION

WT. W/1 HP. 20" = 850#
WT. W/2 HP. 20" = 855#
WT. W/3 HP. 20" = 875#
WT. W/1 HP. 26" = 890#
WT. W/2 HP. 26" = 895#
WT. W/3 HP. 26" = 915#

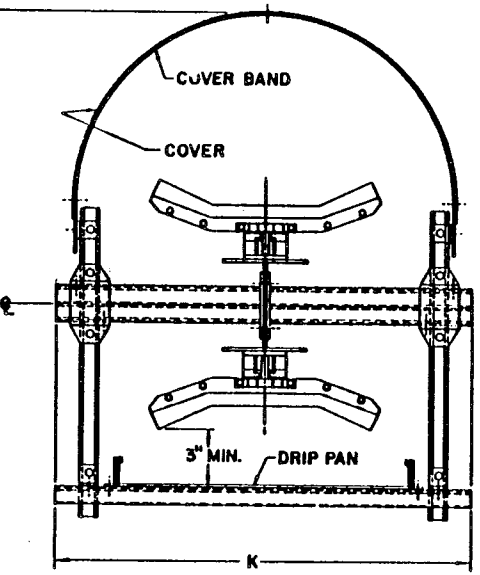
SECTION X-X

TYPICAL CONVEYOR CROSS SECTION

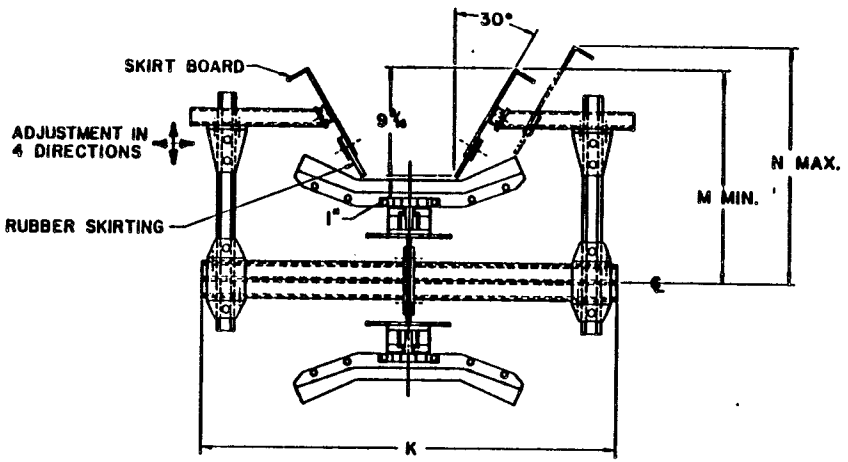
WT./FT. 20" = 45#
WT./FT. 26" = 50#

TYPICAL TAKE-UP STATION

WT. 20" = 310#
WT. 26" = 330#



TYPICAL DRIP PAN AND COVER CROSS SECTION



TYPICAL SKIRT BOARD CROSS SECTION

CONVEYOR DIMENSIONS

BELT WIDTH	A	B	C	D	E	F	G	H	J	K	L	M	N
20"	9¼	1⅞	1⅞	11	16⅝	32⅝	14⅝	29⅛	21⅛	36¾	27⅝	19 7/16	21 9/16
26"	11⅝	2⅝	1⅝	12⅝	17⅝	35 ½	15⅞	31¾	22 7/16	42¾	27⅝	19 9/16	22⅞

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MAR 1 9 1997

TITLE
MODEL I CONVEYOR
STANDARD CROSS SECTIONS

SERPENTIX CONVEYOR CORP.
WESTMINSTER, CO. 80030

DRAWING NO. T-0148-001-C REV.

SEC. 20, PAGE 4, DATE 3-22-84, REV.

EleVeyor® BULKLIFT CONVEYORS

General Description

The C-TECH EleVeyor was developed for conveying and elevating difficult-to-handle bulk materials such as clay, sludge, abrasive, odorous, and similar products which tend to create environmental, maintenance and housekeeping problems.

The operating principle of the EleVeyor is simple: two flat belts are arranged to hold the product in a continuous "sandwich" mode. The rollers supporting the belts are designed to permit expansion of the belt sandwich along the belt center line, while maintaining a tight seal along both edges. Dual swivel-mounted belt scrapers act on both belts to clean off any residues sticking to the belts at the discharge.

The EleVeyor structure consists of four Standard Modules and three Variable-Length Make-Up Sections:

Standard Modules

1. Carry Belt Tail Module.
2. Cover Belt Tail Module.
3. 90 Degree Corner Module.
4. Drive and Discharge Module.

Variable-Length Make-Up Sections

5. Infeed Intermediate Section.
6. Pressure (Lift) Section.
7. Intermediate Discharge Section.
8. Other than 90 Degree Incline Corner Section.

Sections 5, 6, & 7 are utilized to make-up the required length between working points.

The structural casings enclose the entire system and permit temperature and odor control, while assuring minimum housekeeping requirements.

Specially designed highly wear-resistant belting is used by C-TECH for original equipment. Ordinary rubber conveyor belting may be substituted, but may not give comparable service.

EleVeyor® is a registered trademark of C-TECH CORPORATION.

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C-TECH Corporation

TITLE	DRAWING NO.	SHT.	REV

The C-TECH TRACKUSHION™ idler rollers are mounted on removable cover plates, permitting servicing from either side without removal of the casing covers. Standard TRACKUSHION rollers are fitted with labyrinth seals and permanently lubricated bearings for minimum maintenance.

Various options including Straight Line, "L", "Z", and "C"-line configurations, other than 90 degree incline angles powerroll, internally driven head pulley (no chains, belts, or guards required), stainless steel solid or expanded metal covers, etc. are available to meet special requirements.

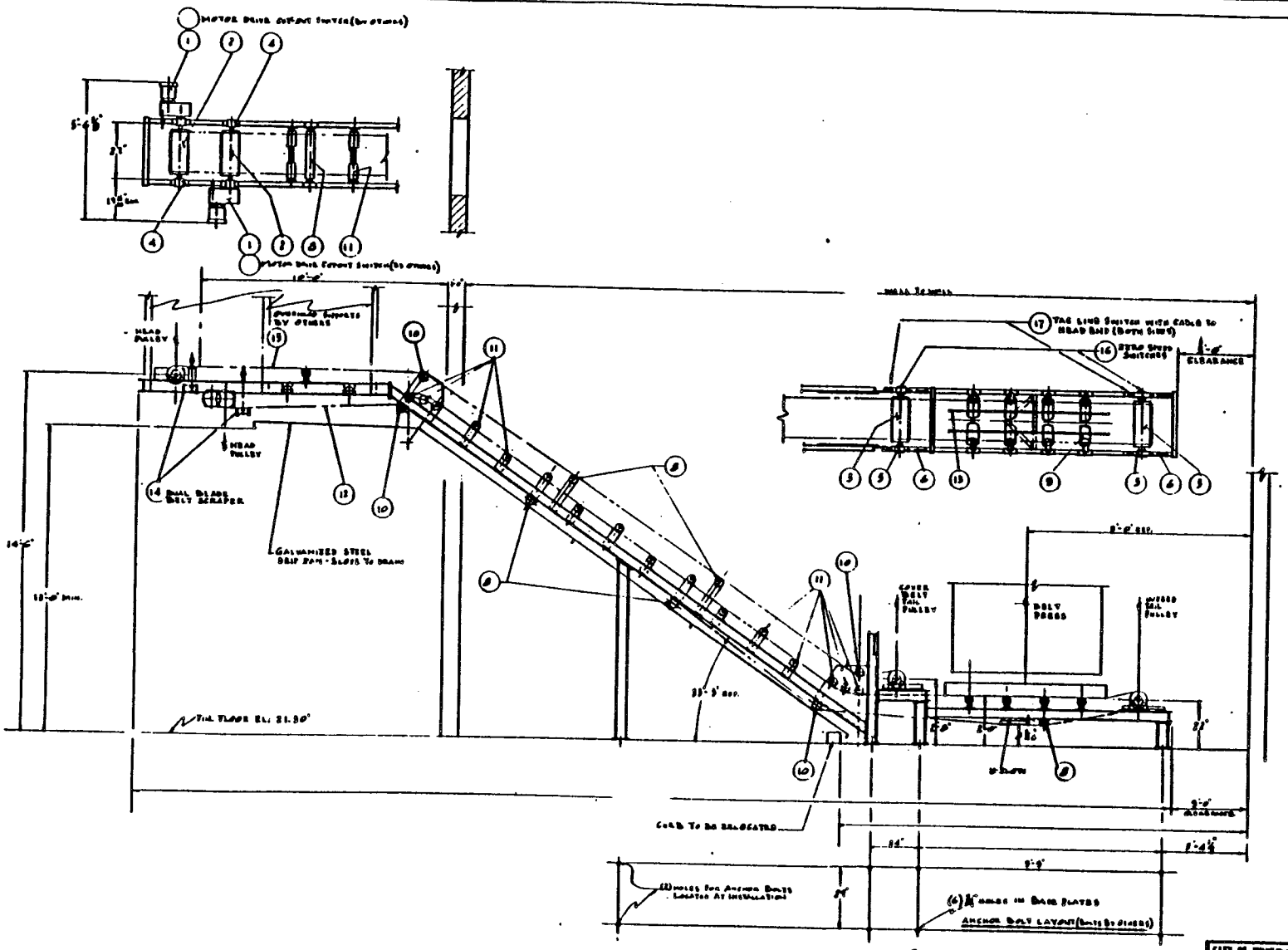
All C-TECH EleVeyor® systems are custom built to meet specific requirements. They are supplied in pre-assembled sections suitable for over-the-road shipment via common carriers.

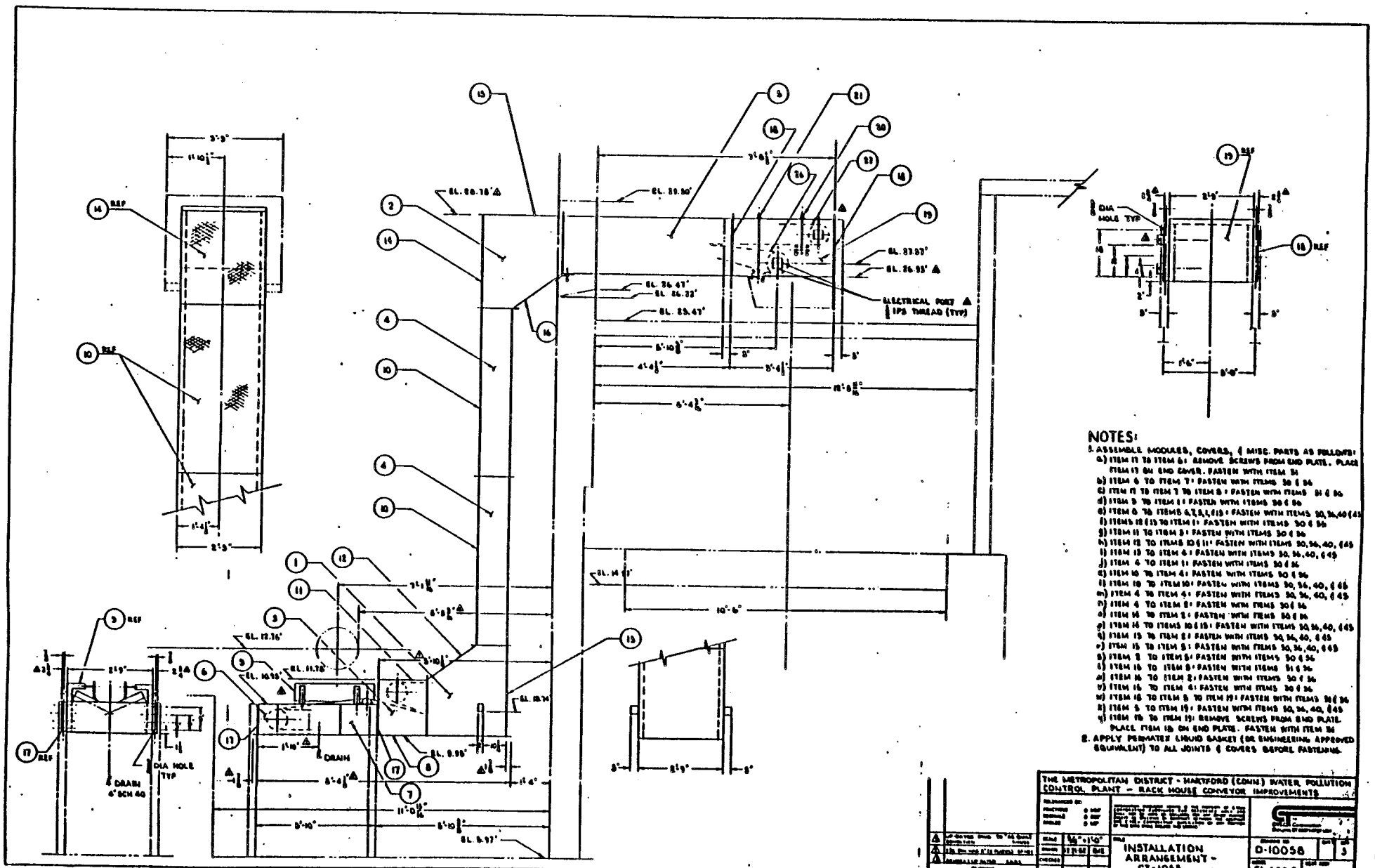
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C-TECH Corporation

TITLE	DRAWING NO	SHT.	REV


TAG LINE SWITCH WITH CABLE TO HEAD END (BOTH SIDES)
HEAD PULLEY
GALVANIZED STEEL
BELT SCRAPER
TAIL PULLEY
BELT PRESS
CURB TO BE RELOCATED
ANCHOR BOLT LAYOUT



NOTES:

1. ASSEMBLE MODULES, COVERS, & MISC. PARTS AS FOLLOWS:
   a) ITEM 17 TO ITEM 6: REMOVE SCREWS FROM END PLATE. PLACE ITEM 17 ON END COVER. FASTEN WITH ITEM 36
   b) ITEM 6 TO ITEM 7: FASTEN WITH ITEMS 36 & 86
   c) ITEM 17 TO ITEM 7 TO ITEM 8: FASTEN WITH ITEMS 36 & 86
   d) ITEM 8 TO ITEM 1: FASTEN WITH ITEMS 36 & 86
   e) ITEM 8 TO ITEMS 6, 7, 8, 1, & 13: FASTEN WITH ITEMS 30, 36, 40 & 45
   f) ITEMS 12 & 13 TO ITEM 1: FASTEN WITH ITEMS 30 & 36
   g) ITEM 11 TO ITEM 3: FASTEN WITH ITEMS 30 & 36
   h) ITEM 12 TO ITEMS 10 & 11: FASTEN WITH ITEMS 30, 36, 40, & 45
   i) ITEM 13 TO ITEM 6: FASTEN WITH ITEMS 30, 36, 40, & 45
   j) ITEM 4 TO ITEM 11: FASTEN WITH ITEMS 30 & 36
   k) ITEM 10 TO ITEM 4: FASTEN WITH ITEMS 30 & 36
   l) ITEM 10 TO ITEM 10: FASTEN WITH ITEMS 30, 36, 40, & 45
   m) ITEM 4 TO ITEM 4: FASTEN WITH ITEMS 30, 36, 40, & 45
   n) ITEM 4 TO ITEM 2: FASTEN WITH ITEMS 30 & 36
   o) ITEM 14 TO ITEM 2: FASTEN WITH ITEMS 30 & 36
   p) ITEM 14 TO ITEMS 10 & 15: FASTEN WITH ITEMS 30, 36, 40, & 45
   q) ITEM 15 TO ITEM 2: FASTEN WITH ITEMS 30, 36, 40, & 45
   r) ITEM 15 TO ITEM 5: FASTEN WITH ITEMS 30, 36, 40, & 45
   s) ITEM 2 TO ITEM 5: FASTEN WITH ITEMS 30 & 36
   t) ITEM 16 TO ITEM 5: FASTEN WITH ITEMS 31 & 36
   u) ITEM 16 TO ITEM 2: FASTEN WITH ITEMS 30 & 36
   v) ITEM 16 TO ITEM 4: FASTEN WITH ITEMS 30 & 36
   w) ITEM 18 TO ITEM 5 TO ITEM 19: FASTEN WITH ITEMS 30 & 36
   x) ITEM 5 TO ITEM 19: FASTEN WITH ITEMS 30, 36, 40, & 45
   y) ITEM 18 TO ITEM 19: REMOVE SCREWS FROM END PLATE. PLACE ITEM 18 ON END PLATE. FASTEN WITH ITEM 36
2. APPLY PERMATEX LIQUID GASKET (OR ENGINEERING APPROVED EQUIVALENT) TO ALL JOINTS & COVERS BEFORE FASTENING.

THE METROPOLITAN DISTRICT - HARTFORD (CONN.) WATER POLLUTION CONTROL PLANT – RACK HOUSE CONVEYOR IMPROVEMENTS

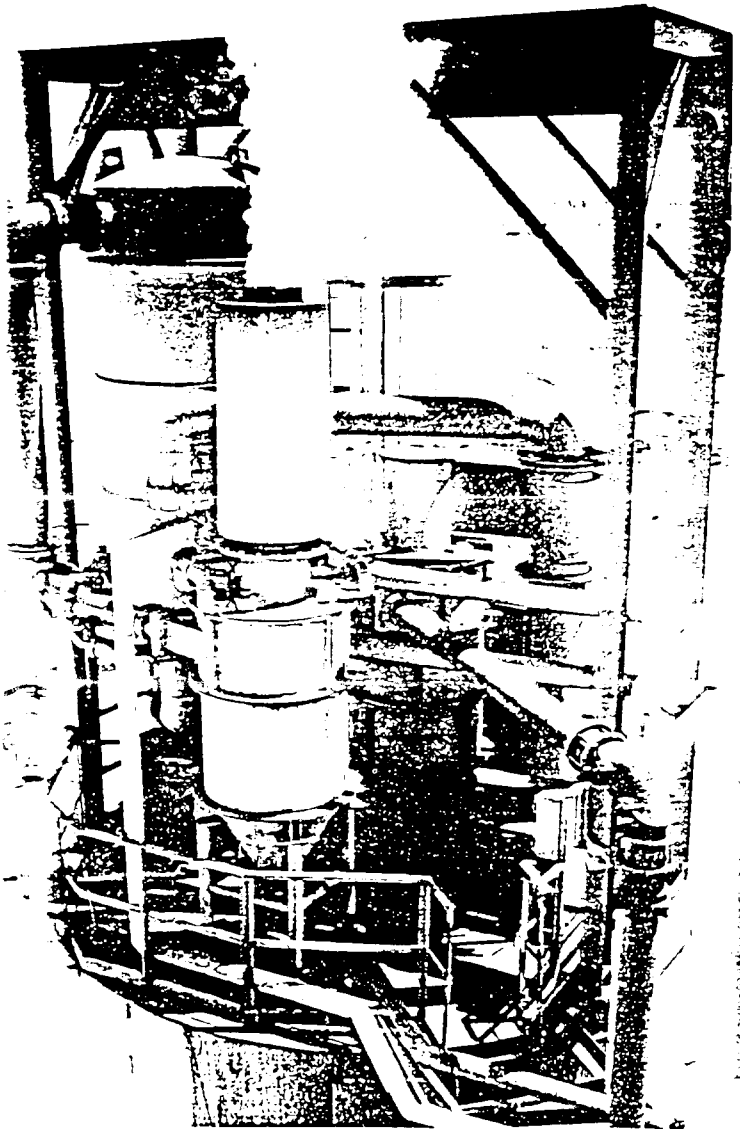
INSTALLATION ARRANGEMENT - CT-1053

D-10058

6L-600-C

National

FOR THE REMOVAL AND STORAGE OF ASH AND FLY ASH



Ash Handling Systems

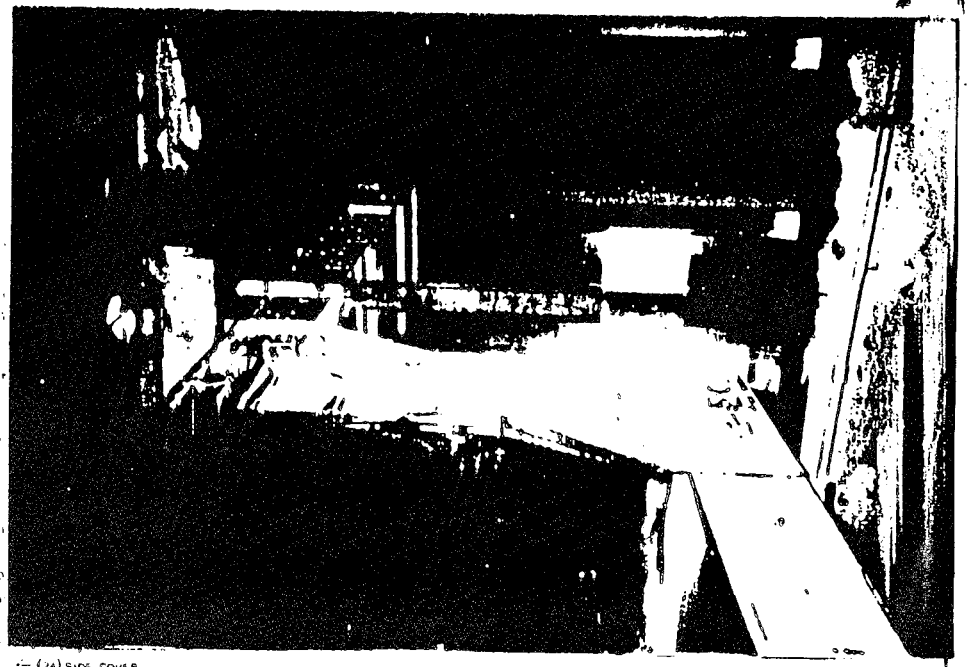
Partial Installation List of National Ash Conveyor Systems:

B.F. Goodrich
Avon Lake, OH
Rochester Products Div., GMC
Rochester, N.Y.
Shippensburg State Teachers College
Shippensburg, PA.
Monsanto Textiles
Decatur, AL.
Ford Motor Company
Wayne, MI.
G+W National Resources
Adrian, MI.
Aamabula, OH
U.S. Steel, Cuyahoga Works
Cleveland, OH
University of Missouri
Columbia, MO.
Holston AAP
Kingsport, TN.
Ashland Oil & Refining
Canton, OH
Ford Motor Company
Lorain, OH
Upper Peninsula Power
L'Anse, MI
Pennsalt Plastics, Inc.
Johnsonburg, PA.
[illegible]
Mocona, GA.
[illegible]
Wamsutta, MA.
[illegible]
Calvert City, KY.
[illegible]
Mt. Vernon, IN.
[illegible]
Omaha, NB.
[illegible]
Dayton, OH
[illegible]
Louisville, KY.
[illegible]
Frederick, MD.
[illegible]
[illegible]
[illegible]
[illegible]
Ebensburg, PA.
[illegible]
Poling, PA.
[illegible]
Follansbee, WV.
Ohio Brass Co.
Mansfield, OH
[illegible]
Decatur, AL.
Union Carbide
Clark, Fridge, TN.
[illegible]
Virginia, Electric, VA.
[illegible]
Columbia, South Carolina
[illegible]
Chesapeake, VA.
[illegible]
Greensboro, NC.
[illegible]
Sydney, Australia

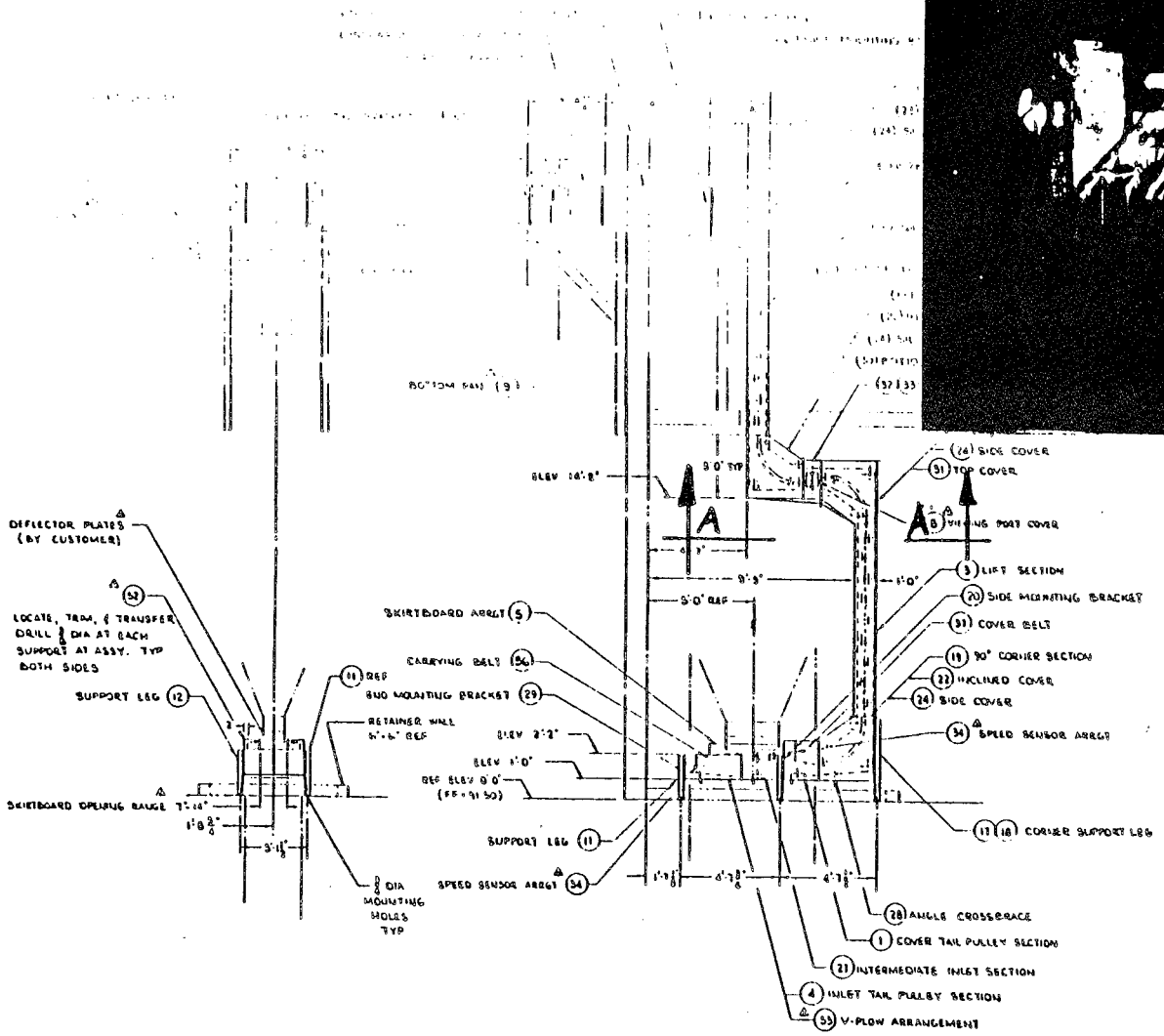
National manufactures a comprehensive line of standard, dependable ash conveyor systems for industrial and institutional boiler plants - Since 1933.

national CONVEYORS COMPANY

[illegible] BERGEN COUNTY, NEW JERSEY



VIEW "A-A"



NOTES:

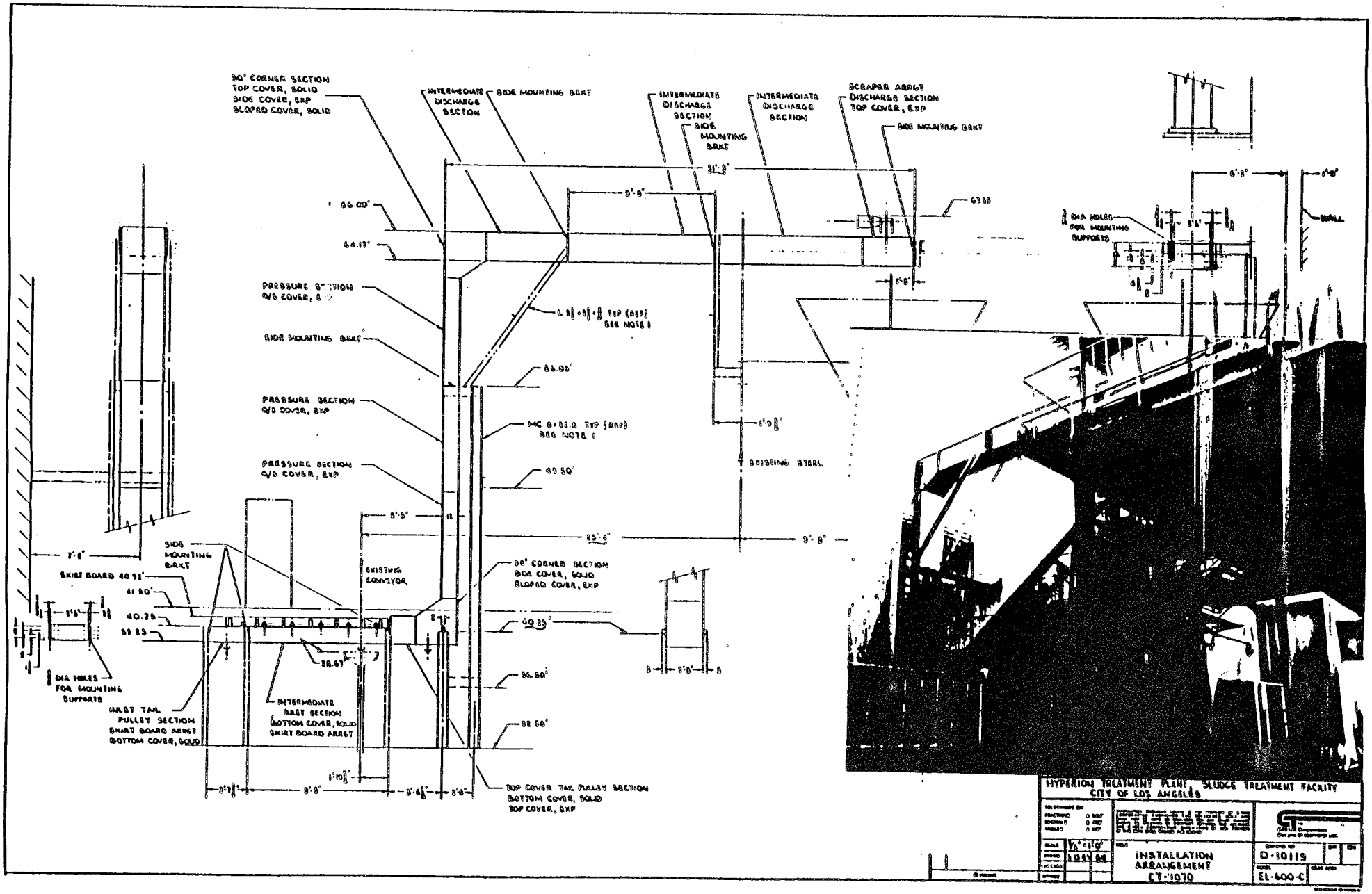
1. APPLY DOW CORNING 110 RTV 790 BUILDING SEALANT, OR APPROVED EQUIVALENT, TO ALL JOINTS BEFORE SECURING.
2. USE ITEMS 40, 44, 48, & 68 FOR SECURING:
   a) MODULES TO MODULES
   b) COVERS TO MODULES
3. USE ITEMS 41, 44, 48, & 68 FOR SECURING:
   a) SIDE MOUNTING BRACKETS TO MODULES
   b) SUPPORT LEGS & SUPPORT ANGLES TO SIDE MOUNTING BRACKETS

ALBERT WHITTED WASTEWATER TREATMENT PLANT, ST PETERSBURG, FLA - MODIFICATIONS, CROWSON-DYKLAND & ASSOCIATES - PROJ NO 08.130

INSTALLATION ARRANGEMENT PROJ NO 120

D-10318 | 2

IL 600 C

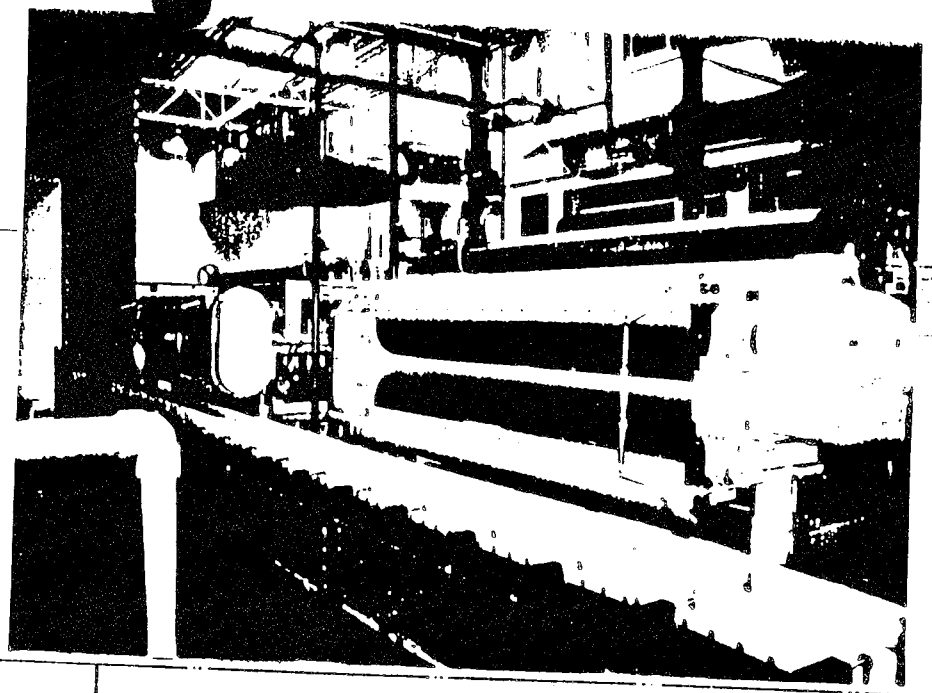


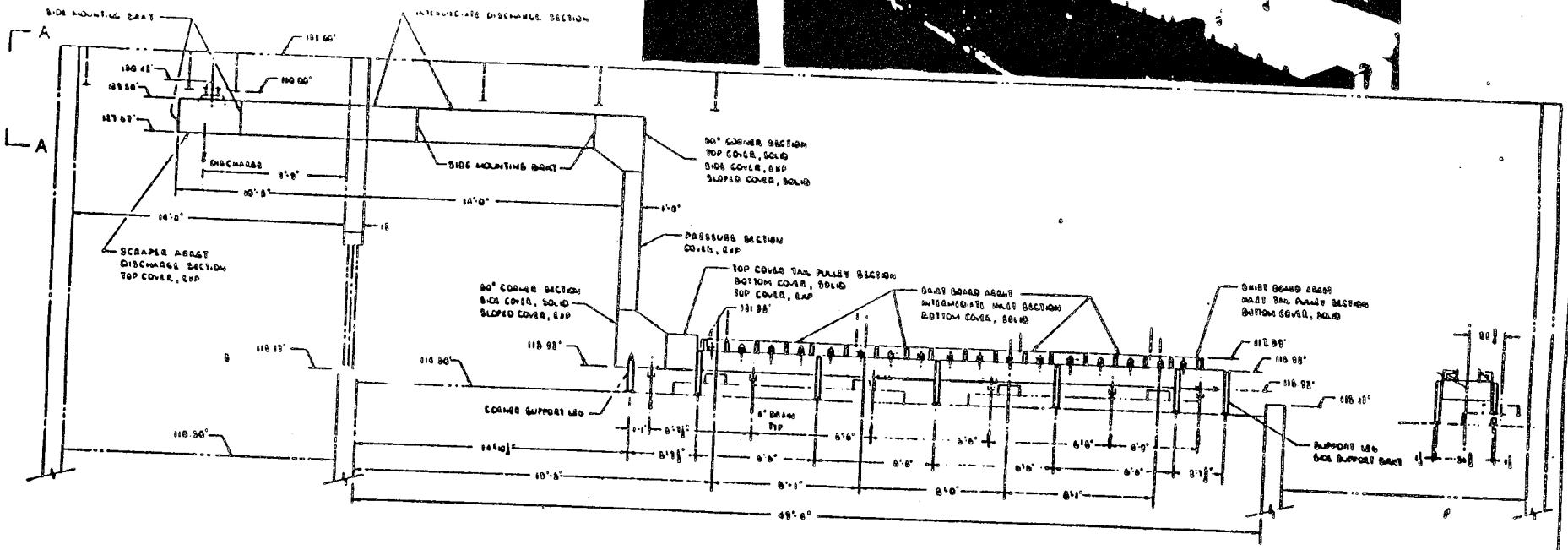
HYPERION TREATMENT PLANT, SLUDGE TREATMENT FACILITY
CITY OF LOS ANGELES

INSTALLATION ARRANGEMENT
CT-1010

D-10119

EE-600-C



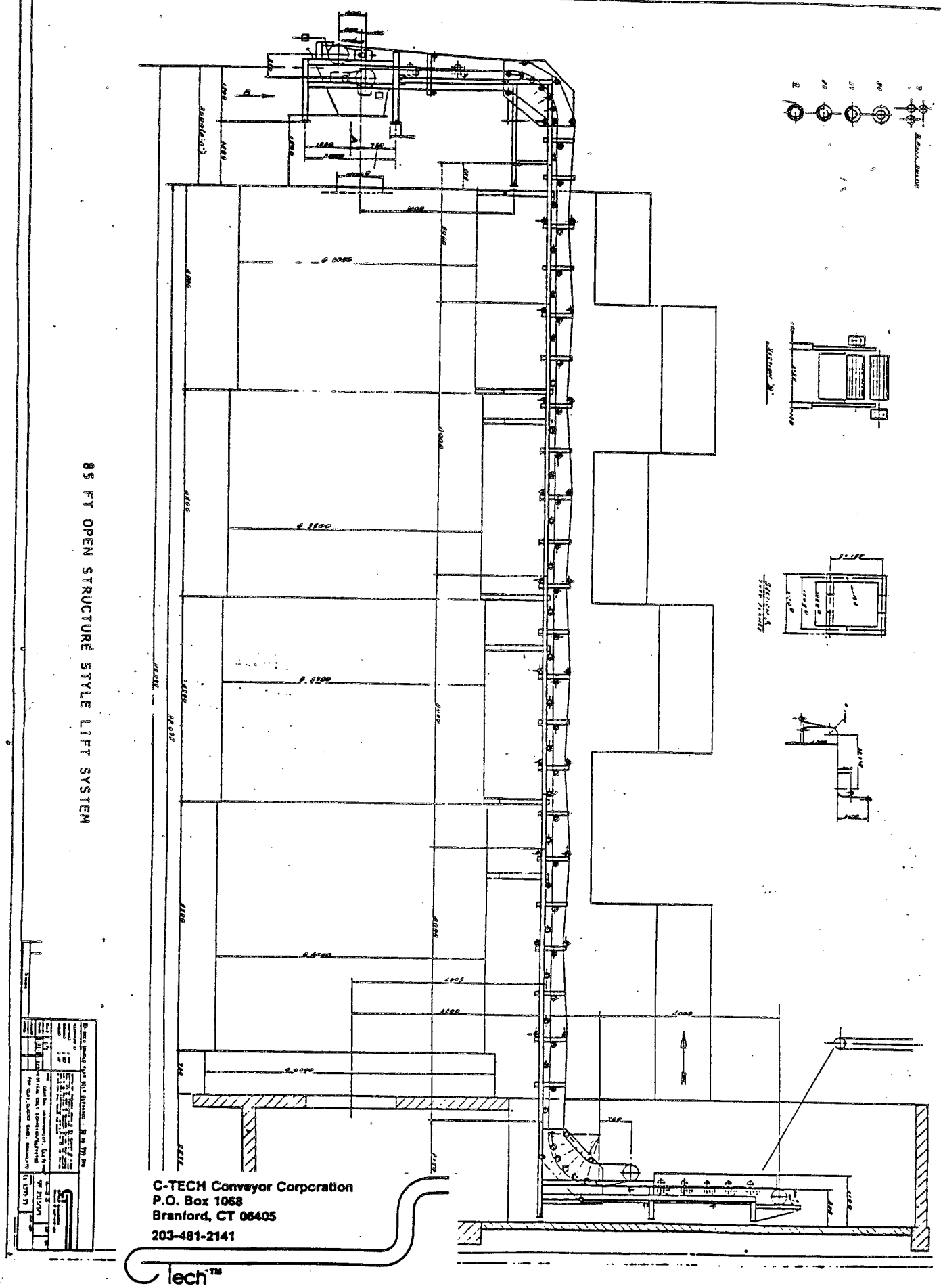


TOWN OF STRATFORD, CONN. WATER POLLUTION CONTROL PLANT MODIFICATION, CONTRACT #8
SLUDGE CONVEYOR, SECTION 16881, EPA PROJECT NO. C090891-05

INSTALLATION ARRANGEMENT
CS-1066

D-10140

EL 600-C

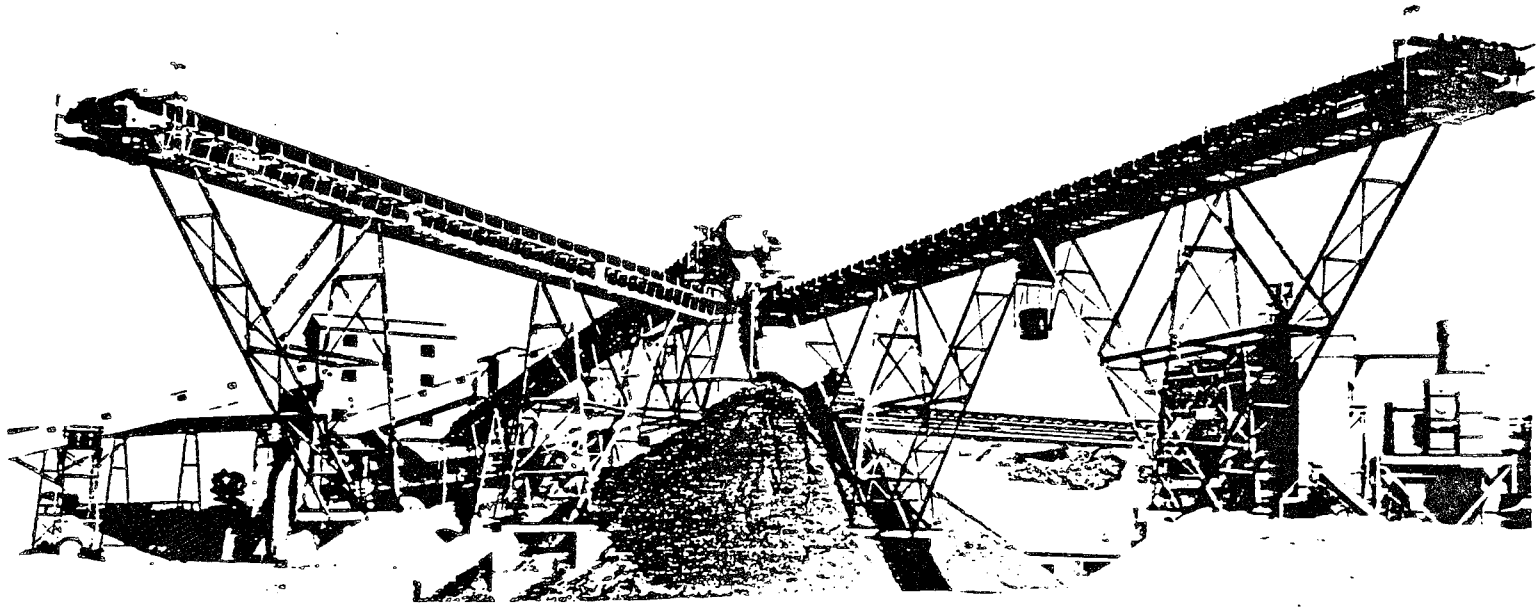


85 FT OPEN STRUCTURE STYLE LIFT SYSTEM

C-TECH Conveyor Corporation
P.O. Box 1068
Branford, CT 06405
203-481-2141

MANUFACTURING CORPORATION®
SUBSIDIARY OF PORTEC INC.

BULLETIN
1300



CONVEYORS

FEATURES

- Low INITIAL cost
- Lower FINAL cost
- All-welded Frame construction
- Factory Pre-assembled Frame Sections
- Simple and ultra-fast erection

BELT WIDTHS
18" thru 72"

BELT LENGTHS
Any length

FRAME TRUSS DEPTHS
24"-30"-36"-42"-60"

*Where necessary for purposes of illustration . . . guards, drives or motors may not have been installed on photos appearing in this brochure.

SALES AND SERVICE

KOLBERG®
MANUFACTURING CORPORATION
SUBSIDIARY OF PORTEC INC.
YANKTON, SOUTH DAKOTA 57078

UNI PRODUCER PROVED

THE UNI-FRAME – The conveyor frame is perhaps the most important part of the conveyor . . . it must be straight . . . true . . . and strong in order to provide maximum service and maximum belt life. Advantages of KOLBERG **all-welded, factory pre-assembled conveyors** are numerous.

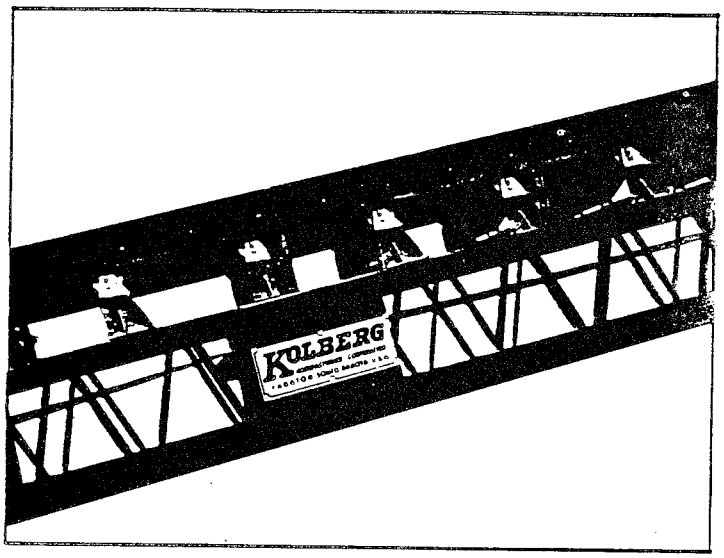
First, UNI-FRAMES are delivered in **preassembled lengths** up to 40-feet long which assure proper alignment and fast erection.

Second, the UNI-FRAME is stronger because chord angles, lattices, cross members and diagonal members are **welded together** into a solid structure.

Third, all structural members are larger and heavier to add strength to the frame. (See illustration)

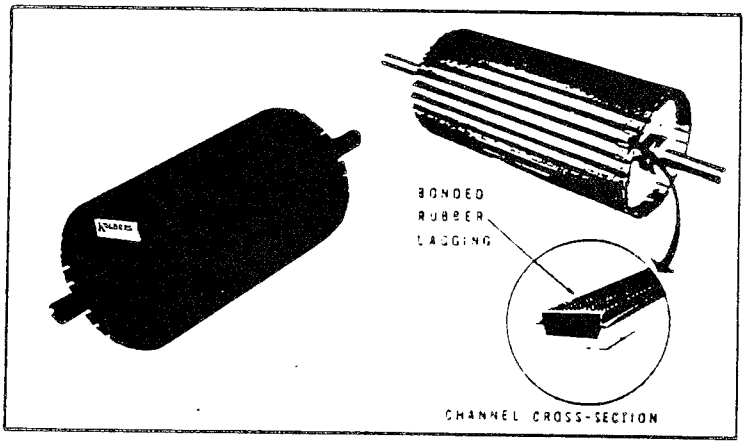
Fourth, at each splice section frame strength is maintained by means of heavy splice plates which secure each section.

Fifth, initial price includes the frame, idlers, return belt cover, terminal equipment and material receiving trough.

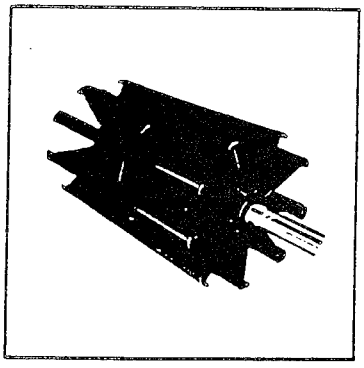


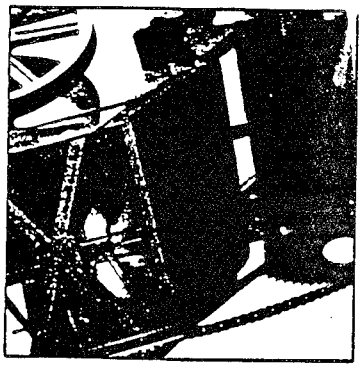
TERMINAL EQUIPMENT . . . PRODUCER PROVED

HEAD PULLEYS – KOLBERG head pulleys are properly designed for diameter and for shaft and bearing strength depending upon belt width, length, capacity and power requirements. But **KOLBERG does more.** The head or driving pulley is KOLBERG designed; standard design includes an all steel bar type head pulley to give positive traction under most conditions. For a few dollars more you can get the new "Bulldog" bar-type, **rubber-vulcanized** pulley with the non-slip grip which provides superior traction under all conditions including moisture or frost.



TAIL PULLEYS – Kolberg Tail Pulleys are available in either rubber-lagged or all-steel types. Both types are self-cleaning. They are mounted in a sliding bearing block and have screw take-ups to adjust belt tension.





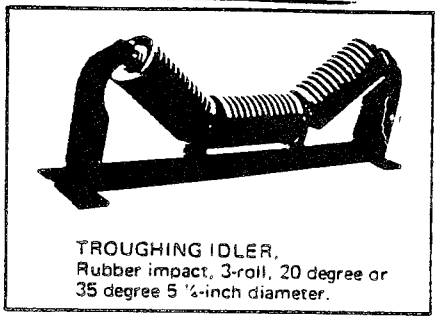
SNUB PULLEYS – The KOLBERG snub pulley is of all steel, bar type construction as shown. It will assist the driving pulley to do its job better because it provides greater belt wrap. A snub pulley is recommended on extra-long conveyors or conveyors having extra-heavy production requirements.

HUBS – You can specify two types of hubs for all pulleys . . . (1) the TAPER-LOCK® hub and (2) the QD hub. Unless otherwise noted on your order all KOLBERG Conveyors are equipped with the QD hub.

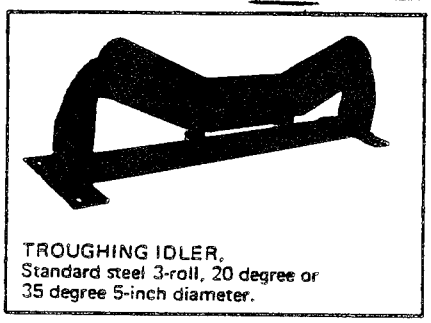
TAPER-LOCK® is a registered trademark of Reliance Electric Company.

NOTE: For details on KOLBERG "Bulldog" Head Pulleys refer to SALES BULLETIN 1000-H.

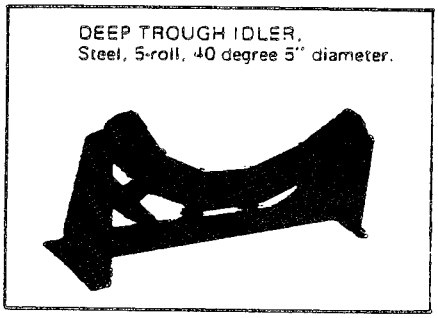
IDLER EQUIPME... DUCER PROVED



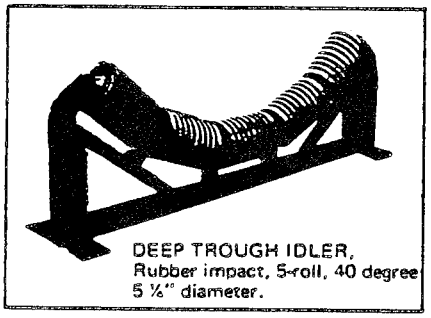
TROUGHING IDLER,
Rubber impact, 3-roll, 20 degree or 35 degree 5 ¼-inch diameter.



TROUGHING IDLER,
Standard steel 3-roll, 20 degree or 35 degree 5-inch diameter.



DEEP TROUGH IDLER,
Steel, 5-roll, 40 degree 5" diameter.



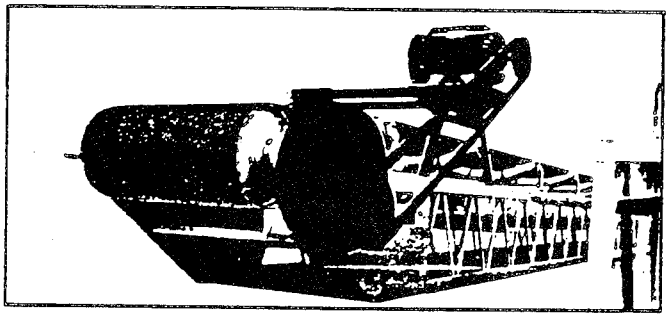
DEEP TROUGH IDLER,
Rubber impact, 5-roll, 40 degree 5 ⅞" diameter.

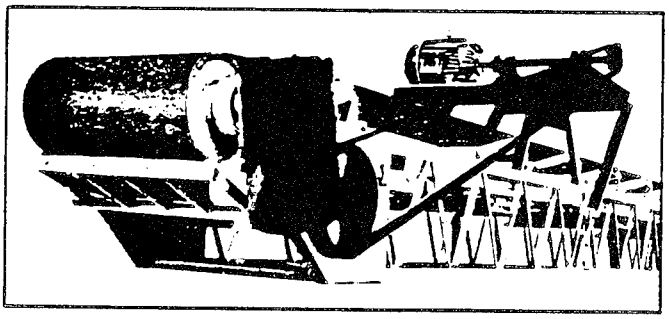
- 18-INCH TO 72-INCH WIDTHS
- RUGGED SELF SHEDDING BASE
- SEALED BALL BEARINGS
- BALANCED SEAMLESS ROLLS
- ROCK-GUARD DEFLECTORS ON END BRACKETS
- THROUGH BEARING SHAFTS
- EQUAL LENGTH ROLLS
- EASY INTERCHANGEABLE ROLLS
- DESIGNED FOR EXTREME RADIAL END THRUST AND IMPACT LOADS.
- 2-DEGREE BUILT-IN FORWARD SLOPE

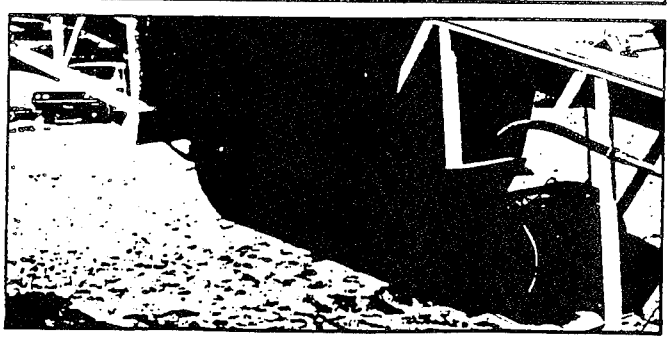
KOLBERG Lattice Frame Conveyors include KOLBERG idlers having a standard diameter of 5-inches and including all features shown above. A choice of troughing idler spacing is available and will usually depend upon meeting the requirements for belt loads and the type of material being handled.

Although all KOLBERG idlers are of the factory sealed ball bearing type, lubricated roller or ball bearings can be furnished if required.

DRIVE EQUIPMENT . . . PRODUCER PROVED





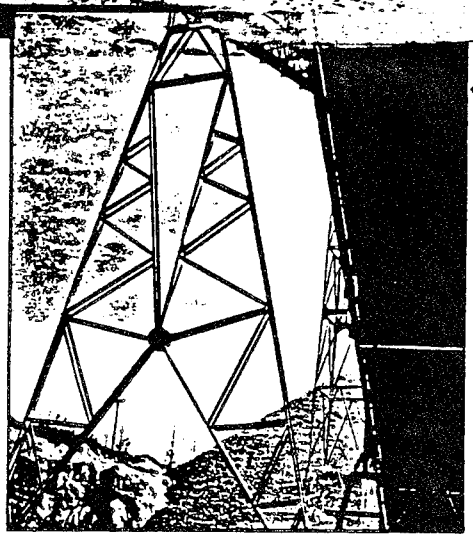


GEAR REDUCER DRIVES – The gear reducer drive is the most efficient of the various drives available. It is totally enclosed and lubricated and it gives the high degree of reduction required between the driving pulley and the power unit.

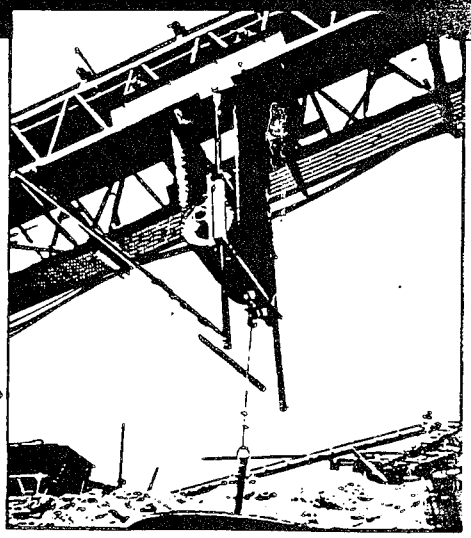
STANDARD DRIVE – The KOLBERG Standard Electric Drive consists of the gear reducer and the necessary belts and sheaves which drive the head pulley. Both the power unit and the reducer are mounted on the same side of the conveyor.

BALANCED DRIVE – The KOLBERG Balanced Electric Drive places the reducer on one side of the conveyor and the power unit on the other splitting the combined weight of the components to either side of the conveyor thus avoiding any tendency to twist the frame.

WRAP DRIVE – The KOLBERG Wrap Drive is an ideal drive for use on exceptionally long, exceptionally high conveyors such as those used in surge pile installations. Its advantages are (1) location at the lower end of the conveyor makes it easily accessible for maintenance and (2) it permits much greater overhang at the head section.

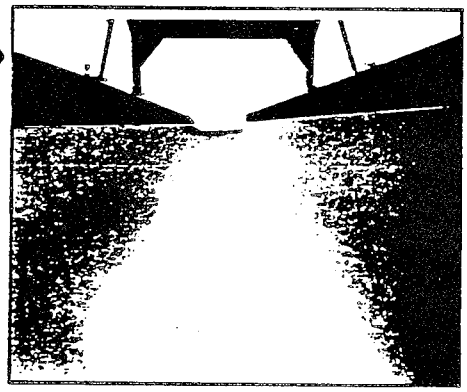


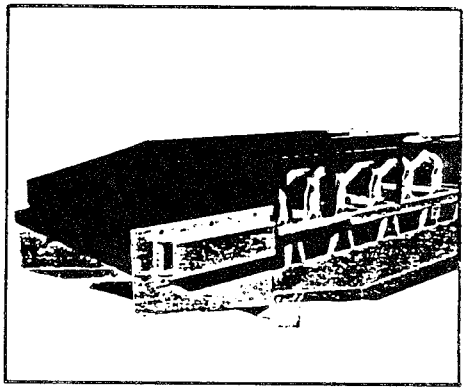
CONVEYOR SUPPORTS – Regardless of your support requirements KOLBERG can supply every type required ranging from anchor supports at the tail section to stockpile head end supports. An intermediate support is shown . . . for the head end support see the front cover.



VERTICAL GRAVITY BELT TIGHTENERS – ON conveyors exceeding 120 feet in length a VGBT is always recommended to provide automatic and uniform tightening of the belt.

ROCK ARRESTER – For many applications Rock Arresters may be desirable . . . especially on heavily loaded belts. They contain all material on the belt thus serving a useful safety function.

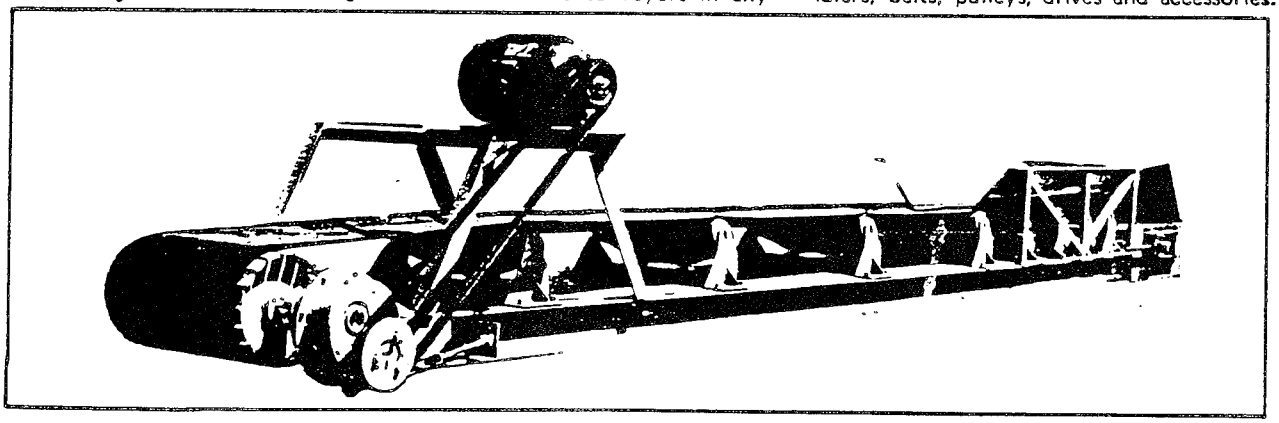




HOPPERS – Illustrated is one form of a material receiving trough with shallow hopper sides. Regardless of your requirements KOLBERG can supply exactly the type needed to match your requirements.

CHANNEL FRAME CONVEYORS

CHANNEL FRAME CONVEYORS – Many installations not requiring a lattice frame conveyor can be provided with a complete range of channel frame conveyors in any length and width necessary. KOLBERG makes channel frames from 6-inches to 12-inches deep complete with your choice of idlers, belts, pulleys, drives and accessories.



Tell us what you need . . . and we'll build it

KOLBERG®
MANUFACTURING CORPORATION
SUBSIDIARY OF **PORTEC** INC.

P.O. Box 20, West 21st St.
Yankton, South Dakota 57078 (605) 665-9311

M rch 30, 1987

HDR Techserv
8404 Indian Hills Drive
Omaha, NE 61114 (402) 399-1132

ATTN: Mr. Randy Grachek

Subject: Hazardous Waste/Soil Cleanup Project
C-Tech File Q-70-3008

Dear Mr. Grachek:

This is simply to confirm our telephone conversations of 3/18/87 and 3/20/87. In response to your inquiry, we quoted budget prices on the following items:

One (1) 39' long trough belt conveyor 7-1/2 hp for 175 TPH of contaminated soil with 30" belt and belt scale with 4-20mA isolated output.

One (1) 39' by 24" belt conveyor 3 hp to handle 75 TPH of add mix with belt scale, same as above.

One (1) 42' x 30" belt conveyor 7-1/2 hp to handle mixture from pug mill

All of the above to be inclined not exceeding 20°.

Lot price for above $78,000.00

The above items do not include controls. We have received quotations for AC frequency for the two 39' conveyors which would price them at $6,847.00 for the lot. The control for the 42' conveyor will be a simple on/off control which should be obtained locally.

Continued...

If this project progresses to a point at which you would require more detailed specifications, we would be pleased to supply same; however, we would require your more formal inquiry and some layout sketches of the proposed applications.

We thank you for your interest in C-Tech conveyors and hope to serve you in this and other conveyor applications in the future.

Very truly yours,

Werner P. B. Plaut
C-TECH CONVEYOR CORPORATION

WPBP/pap

Encs.

SERPENTIX

Serpentix Conveyor Corporation
9085 Marshall Ct.
Westminster, CO 80030
(303) 430-8427 Telex: 216-151 SERP UR

March 19, 1987

HDR Environmental
8404 Indian Hills Drive
Omaha, NE 68114-4049

Attention: Mr. Randy Graycheck

Subject: Hazardous Waste Project

Reference: Our Various Telephone Discussions
On March 17 and March 18, 1987

Dear Randy:

Based on the latest parameters given to us, here is a cost estimate for the various conveyors. Time did not permit us to prepare individual layouts like our proposal drawing No. 1482-B prepared for you on January 20, 1987.

All the quoted production units will be as per drawing No. I-0148-002-C, Model "H", 32 inch wide belt pans, 100 F.P.M. belt speed, 5 horsepower motor. All are to have 30° angle incline maximum and all curve with a 9 foot radius. All are complete with a totally enclosed cover bolted to the full length drip pans and supports similar to those shown on drawing No. 1482-B and drawing No. I-0148-002-C.

PRODUCT CONVEYORS

No. 1 Sludge and Soil

Bulk density:	100 lbs./cu. ft.
Loading:	130 cu. yd./hr. = 175 T.P.H.
Dimensional requirements:	39' horizontal distance
	13' elevation change

A Serpentix Model "H" can be designed in this area utilizing the basic configuration as shown on drawing No. 1482-B.

Calculations:

Centerline to Centerline:	38.6 feet
Horizontal distance:	35.3 feet
Elevation change:	13 feet
Budget price:	$41,000.00

If you want the same configuration conveyor with a horizontal distance of 39 feet, add $2,220.00.

No. 2 Soil

Bulk Density:	110 lbs./cu. ft.
Loading:	50 cu. yds./hr. = 75 T.P.H.
Dimensional requirement:	same as for No. 1

Conveyor same as No. 1.

No. 3 Soil/Fly Ash/Sludge

Bulk density:	101 lbs./cu. ft.
Loading:	140 cu. yd./hr. = 190 T.P.H.
Dimensional requirement:	Horizontal distance 42'
	Elevation change 11'

Our design fits into those dimensions.

Calculations:

Centerline to Centerline:	35.3'
Horizontal distance:	31.8'
Budget price:	$40,000.00

If you want the same configuration for a horizontal distance of 42 feet, add $5,000.00.

For this unit we can change the angle of incline to approximately 20° if you want to have the unit fit in the 42 foot horizontal distance and 11 foot elevation.

PILOT SCALE CONVEYORS

Products are the same as above.

No. 1 for 18 cu. yd./hr. or 24 T.P.H.
No. 2 for 7 cu. yd./hr. or 11 T.P.H.
No. 3 for 20 cu. yd./hr. or 26 T.P.H.

For this we use a similar configuration but the unit is a Model "I" as per drawing No. I-0148-001-C. All units will be a Model "I" with 26 inch belt pans, 30 F.P.M., 5 horsepower motor, all to have 30° incline angles and a curve radius of 9 feet. All are with total enclosure bolted to drip pans the full length and supports are similar to those shown on drawing No. 1482-B and drawing No. I-0148-001-C.

Product I - 38 feet horizontal distance, 12 foot elevation.
Product II - 38 feet horizontal distance, 12 foot elevation.
Product III - 40 feet horizontal distance, 10 foot elevation.

Budget price for the Model "I" for the above applications is $30,000.00 each.

Based on Serpentix's extensive experience with handling sludge in many plants all over the U.S.A., we feel our design is the best for hazardous waste. Proper scraping is most important. In the horizontal position all the belt convolutions are pulled flat over the discharge area which is a major advantage to get the best possible scraping. Sludges are very unpredictable due to small changes in moisture or other unforeseen circumstances so we strongly recommend the design as shown.

Please realize that except for the scraper which has a rubber strip attached to it, there is no other item that comes in contact with the belt surface except for the product to be conveyed.

Since we have rather limited information on the specific process requirement, these figures are budget prices. Before offering those units, we will prepare proposal drawings similar to drawing No. 1482-C for each one.

Your interest in our equipment is appreciated.

Sincerely,

Hans Reilingh
Sales Manager

HR/crs

Enclosures: Drawing No. I-0148-001-C
Drawing No. I-0148-002-C
Specification Sheets for Model "H" and Model "I"

cc: MC^2, Inc.

SERPENTIX

Serpentix Conveyor Corporation
9085 Marshall Ct.
Westminster, CO 80030
(303) 430-8427 Telex: 216-151 SERP UR

January 21, 1987

SERPENTIX CONVEYOR QUOTATION NO. HR7-1482-B

for

HDR Environmental Technologies
Omaha, Nebraska
Hazardous Waste Conveyor

APPLICATION DATA

Product:	Hazardous Soil
Density:	85 lbs./cu. ft.
Capacity:	144 T.P.H.

Based on the above data, Serpentix Conveyor Corporation, Westminster, Colorado recommends and offers the following conveying equipment:

CONVEYOR CONFIGURATION

Serpentix Conveyor Model "H". Proposal Drawing No. 1482-B
Drawing No. I-0148-002-C

Centerline to Centerline Length:	30' - 7 1/4"
Belt Width:	32 Inches
Belt Speed:	100 (120) F.P.M.
Elevation Change:	8' - 0"

SERPENTIX CONVEYOR FEATURES

- Belt pans made of neoprene compounded rubber with steel stiffeners and stainless steel attaching hardware.
- Nickel Alloy special hardened steel chain with attachments.
- Basic conveyor structures consisting of: two (2) straight sections, two (2) vertical curved sections, drive and take-up stations all with standard finish.

- Roller carriage assemblies every twenty-four (24) inches assembled with four (4) rollers.

- Drive station terminal assembled complete with three (3) HP, 1750 RPM, 460V/3/60 T.E.F.C. motor,* gear reducer, safety chain and sprockets, V-belts and sheaves, and guard all with manufacturer's standard finish.

- Tension station terminal is assembled with a sprocket, bearings, and a constant pressure spring loaded tensioner.

- Vertical supports complete with standard finish.

- Pretensioned single bar type scraper blade complete with standard finish.

- Drip pans, 16 gauge galvanized supported with Unistrut (permagreen finish) supports.

- Skirt boards, 10 gauge carbon steel with standard finish and Unistrut (permagreen finish) supports four (4) feet long.

- Covers, 22 gauge galvanized steel with Unistrut (permagreen finish) supports with side plates to form a totally enclosed unit (not dust tight).

- Five (5) manuals for operating instruction and maintenance.

- Standard finish is 1.5 mil thick rust inhibitive primer over an SP-6 surface preparation.

TOTAL PRICE F.O.B. WESTMINSTER, COLORADO $32,500.00
(Freight Allowed)

Estimated Shipping Weight: 6,600 pounds

*Note: These components furnished; however, switch function and electrical hook-up with or without interconnections to other electrical components is the responsibility of installing electrical contractor.

FIELD SERVICES

Two (2) trip(s) for equipment inspection, start-up and/or operational instruction, not to exceed a total of two (2) days in included within price.

Note: This service will be provided, when required, following initial payment of the contracted terms of payment by the Buyer (see also quotation paragraphs "Delivery" and "Terms).

FABRICATION AND INSTALLATION

All equipment furnished shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detailed drawings, specifications, engineering data, instructions, and recommendations furnished by Serpentix.

Final assembly of the entire conveyor unit may require the cutting and redrilling of some of the track sections in order to conform with any site deviations (this work shall be performed by the contractor on site).

INSTALLATION/ASSEMBLY MAN HOUR ESTIMATE

We estimate the installation/assembly time for mechanical erection work only to be fifty (50) man hours.

Note that except for the fully assembled drive station section (4 feet long) and tension station section (4 feet long) the conveyor to be furnished is shipped in a knocked-down condition (i.e. the modular track sections, supports, belt pans, drip pans, belt scraper, etc. are typically shipped as components) and not as a fully assembled conveyor.

Field assembly and erection of the conveyor is the responsibility of the installing contractor (see also quotation paragraph entitled "Fabrication and Installation" and Terms and Conditions of Sale Form TC2).

PURCHASER TO FURNISH

This proposal does not include for the following items nor for any other items not specifically mentioned within this quotation:

Federal, state and local, or other taxes.
Cost of performance/supply, or any type, bonds and/or special insurance coverages when applicable.
Licenses and/or permits.
Field assembly including field erection expendables and required handling equipment (see Terms and Conditions Form TC2).
Unloading upon delivery; storage and storage protection.
Foundations and anchor bolts.
Access facilities: Walkways; stairways and ladders.

Electrical: Control panels; starters; conduit and wiring; instrumentation and lighting.
Finish painting.
Lubricants.

DELIVERY

Shipment of this equipment can be made within fourteen (14) to sixteen (16) weeks after receipt of approved drawings. Allow one (1) to two (2) weeks from receipt of a formal purchase order for approval drawing release.

Delivery of the conveyor(s) will be made in two separate shipments i.e.:

1. All components/materials other than conveyor belt pans and attachments.

   Following completion of this assembly phase, Serpentix will provide additional field inspection services, at no cost to the Buyer to ensure that all assembly work, and any necessary adjustments thereto, is complete and correct before possible misassembly is obscured by the addition of belt pans and attachments.

2. Shipment of conveyor belt pans and attachments will be made immediately following completion of Serpentix-provided field inspection services provided that the Buyer has made the initial payment per the contracted terms of payment.

TERMS AND CONDITIONS

Net thirty (30) days with the prices firm for acceptance up to thirty (30) days from date of this quotation.

Forms TC1 and TC2 are a part of this quotation.

Notes: 1. The firm price is also contingent upon acceptance of the equipment at jobsite within twelve (12) months from date of this quotation; price is, thereafter, subject to an escalation rate of one per cent (1%) of the quoted price for each succeeding calendar month.

2. Initial payment for the provided conveyor(s), per the contracted terms of payment, must be made prior to second shipment of conveyor belt pans and attachments (see also quotation paragraph "Delivery").

3. In the event the Buyer defaults on any of the contracted terms of payments, the full amount then remaining unpaid shall, at the option of the Seller, immediately become due and payable including actual cost of collection, attorneys fees and interest of twelve per cent (12%) per annum on all unpaid and past due monies.

NOTICE OF SERPENTIX PATENT RIGHTS

This conveyor is manufactured under United States Patent Nos. 4,205,745; 4,438,842; and 4,461,378; other United States, Canadian and foreign patents existing or pending.

Please refer all questions concerning this quotation directly to Mr. Hans Reilingh at Serpentix Conveyor Corporation.

Sincerely,

Hans Reilingh
Sales Manager

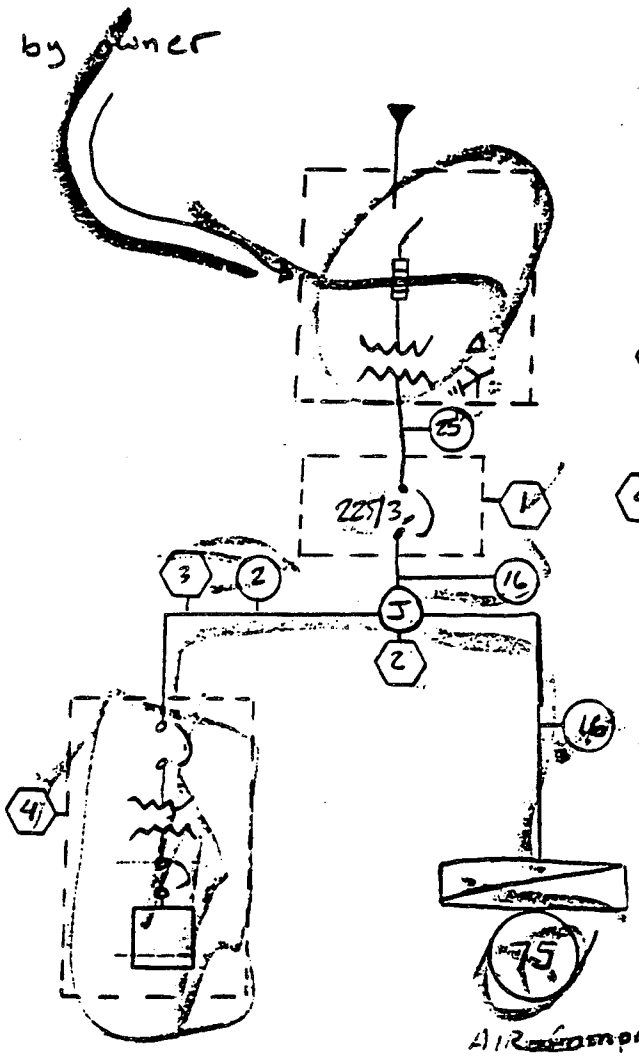
HR/crs

Enclosure: Drawing No. 1482-B
Drawing No. I-0148-002-C
Specification Sheet
Terms and Conditions

Project	Computed
Subject	Date / Sht. / Of

NOTES

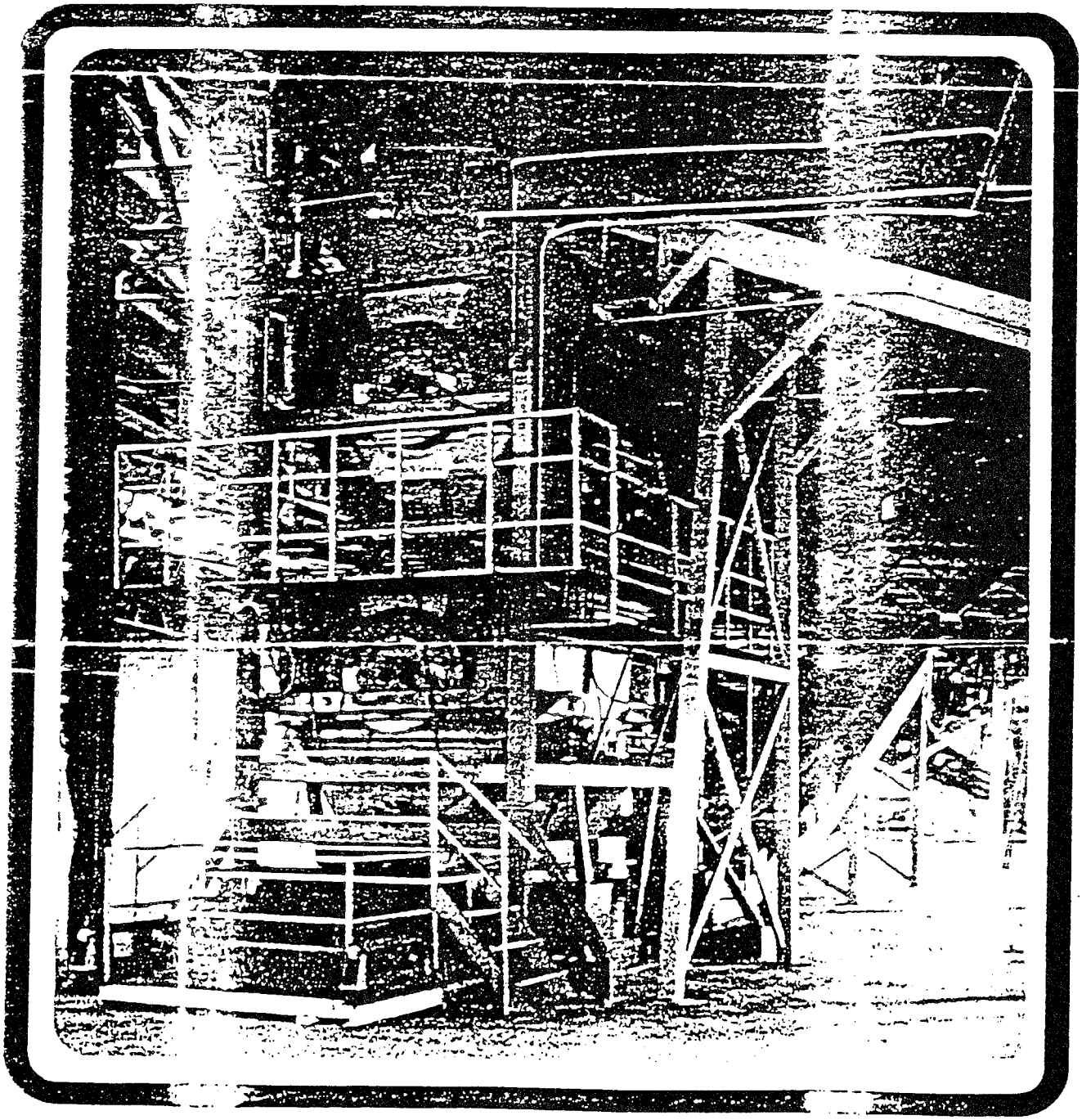
1. 225/3, 480 Volt main circuit breaker. UL listed for service entrance provide breaker in NEMA 3-R enclosure
2. NEMA-4 Junction box. size per NEC.
3. Tap Feeder shall not exceed 10'-0" maximum.
4. Mini-power center: includes 10 KVA, 480V - 120/240 V Transform, 8 - 20 Amp one pole circuit breaker panel, and Primary and secondary overcurrent protection. Equal to Westinghouse Model P48G11S10M, in NEMA-3R enclosure



Pump station one line diagram

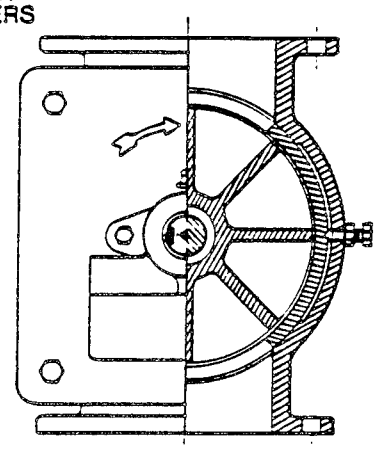
Mike Edgar

ROTO-WEIGH

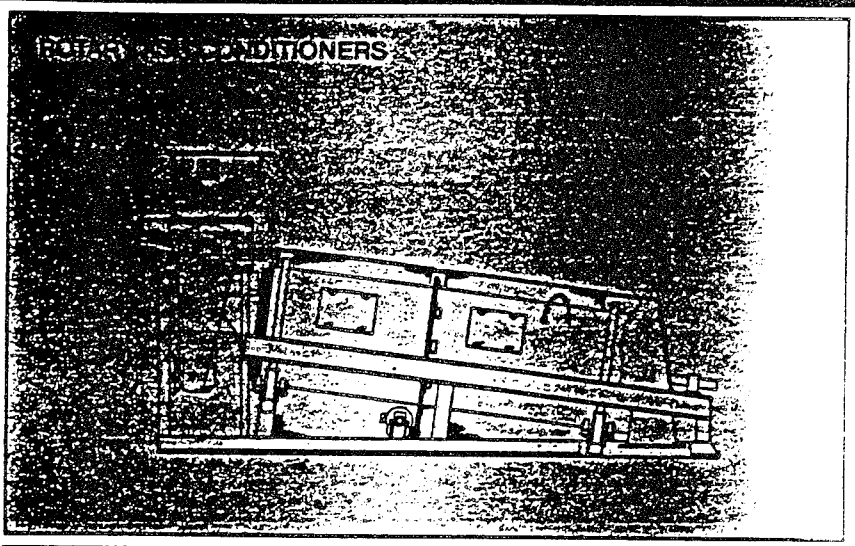


ASH-CONVEYOR COMPONENTS

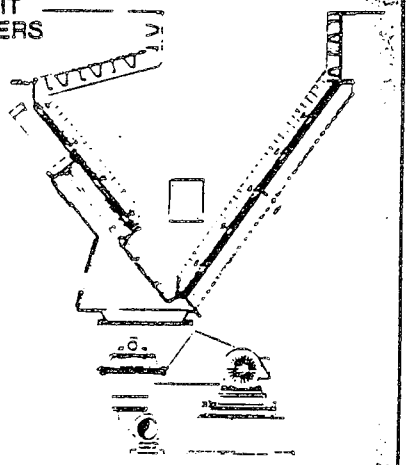
ROTARY FEEDERS



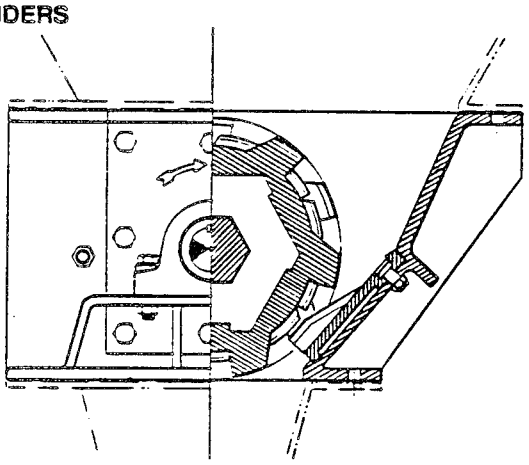
ROTARY [illegible] CONDITIONERS



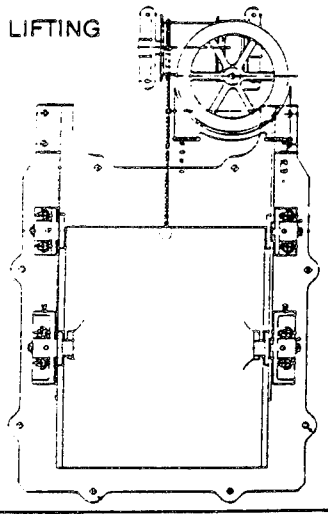
ASH PIT HOPPERS



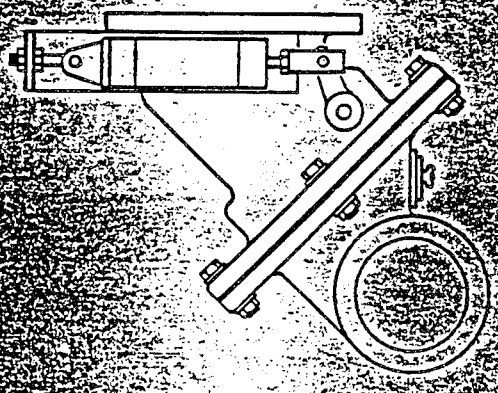
CLINKER GRINDERS



VERTICAL LIFTING FURNACE DOORS



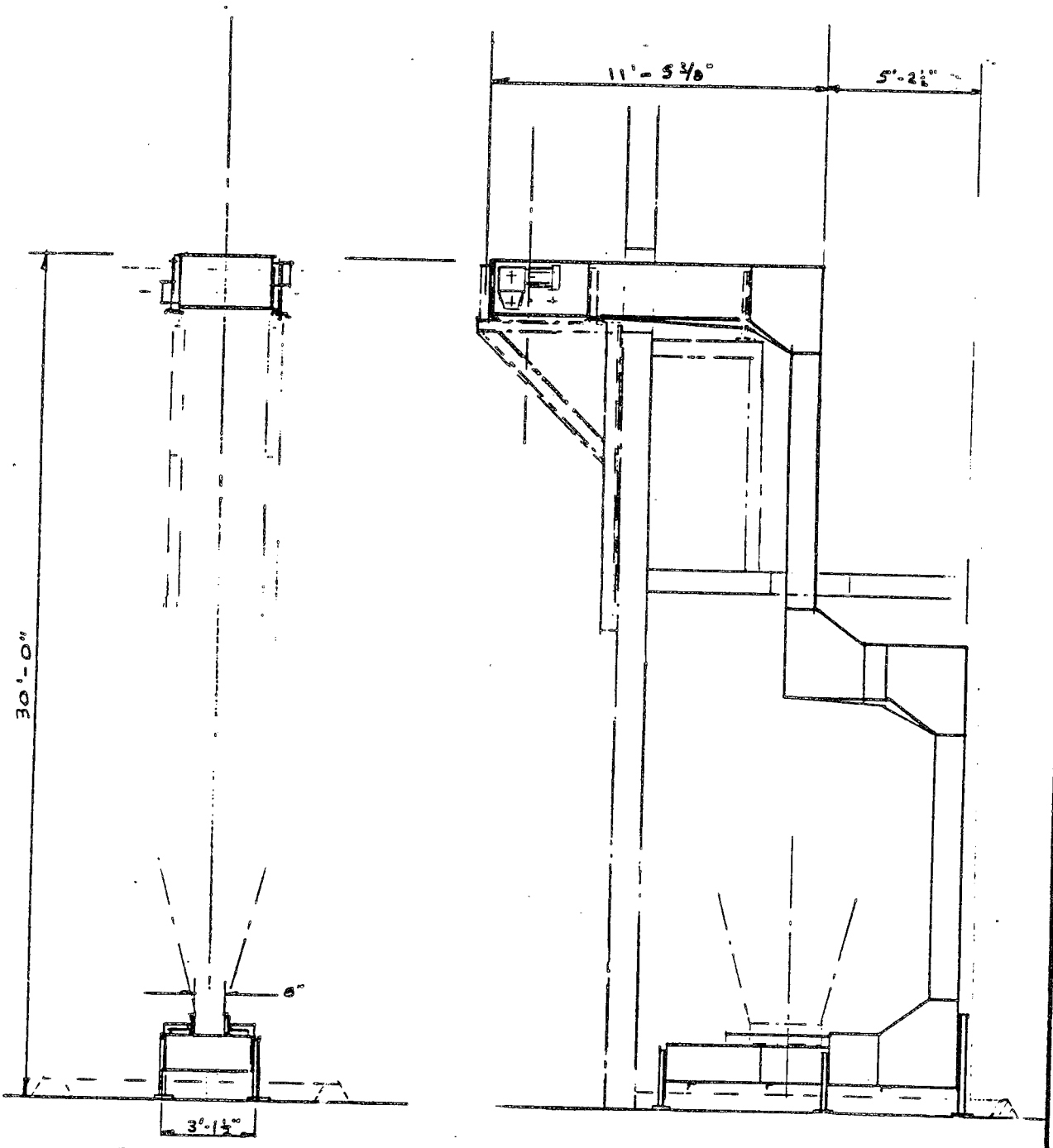
DISC VALVES



Let us help you in the planning stage for new boiler plants, additions to existing plants, accessories; and replacements.

25 Industrial Ave., Fairview N.J. 07022 • (201)945-9136 • Telex:12-9194 Nat Conv Favw

National CONVEYORS COMPANY, INC.



REDUCED IF 8½" x 11" FORM

ALBERT WHITTED WASTEWATER TREATMENT PLANT, ST. PETERSBURG, FLORIDA
CROWSON DE YOUNG + ASSOCIATES, CLEARWATER, FLORIDA

TOLERANCES ON	
FRACTIONS	± 1/64"
DECIMALS	± .005"
ANGLES	± 1/2°

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C-TECH Conveyor Corporation

SCALE	1/4" = 1'	
DRAWN	5-9-89	WP
CHECKED		
APPROV.		

TITLE: PRIMARY SCREENINGS ELEVATOR, ELEVEYOR® BRAND DUAL BELT SYSTEM

DRAWING NO.	SHT.	REV
J-120/Q-31-102-1		
MODEL	NEXT ASSY.	
EL-600-24		

national

PNEUMATIC ASH CONVEYOR

DESCRIPTION OF SYSTEM OPERATION

Illustrated is a typical National Vacuum Ash Conveyor System, designed to service all of the bottom ash and fly ash collection points of a boiler.

The ash is transported to the ash storage silo via a closed conveyor duct by means of vacuum created by a steam jet or mechanical exhauster. It is directed to the centrifugal receiver unit and secondary separator where approximately 97% of the material is collected. From this point the remaining entrained dust in the exhaust air is directed to the air jet filter for final separation prior to atmospheric exhaust. If the vacuum for the system is created by steam, the outlet pipe of the air jet filter is connected to a National multi-jet steam exhauster unit, followed by a steam condenser. When a mechanical exhauster is used, then the outlet piping of the air jet filter is piped directly to it.

The system operates continuously on an automatic basis, with a conveying cycle of approximately 80 seconds and a dump cycle of approximately 15 seconds. When the steam exhauster unit is the method used to provide air flow, the steam is delivered to the exhauster by an automatically operated steam valve, creating a vacuum in the system for the conveying of the ash or fly ash. To allow the collected contents of the receiving equipment to discharge into the silo, the conveying vacuum is automatically interrupted, thereby permitting the hinged discharge gates to open.

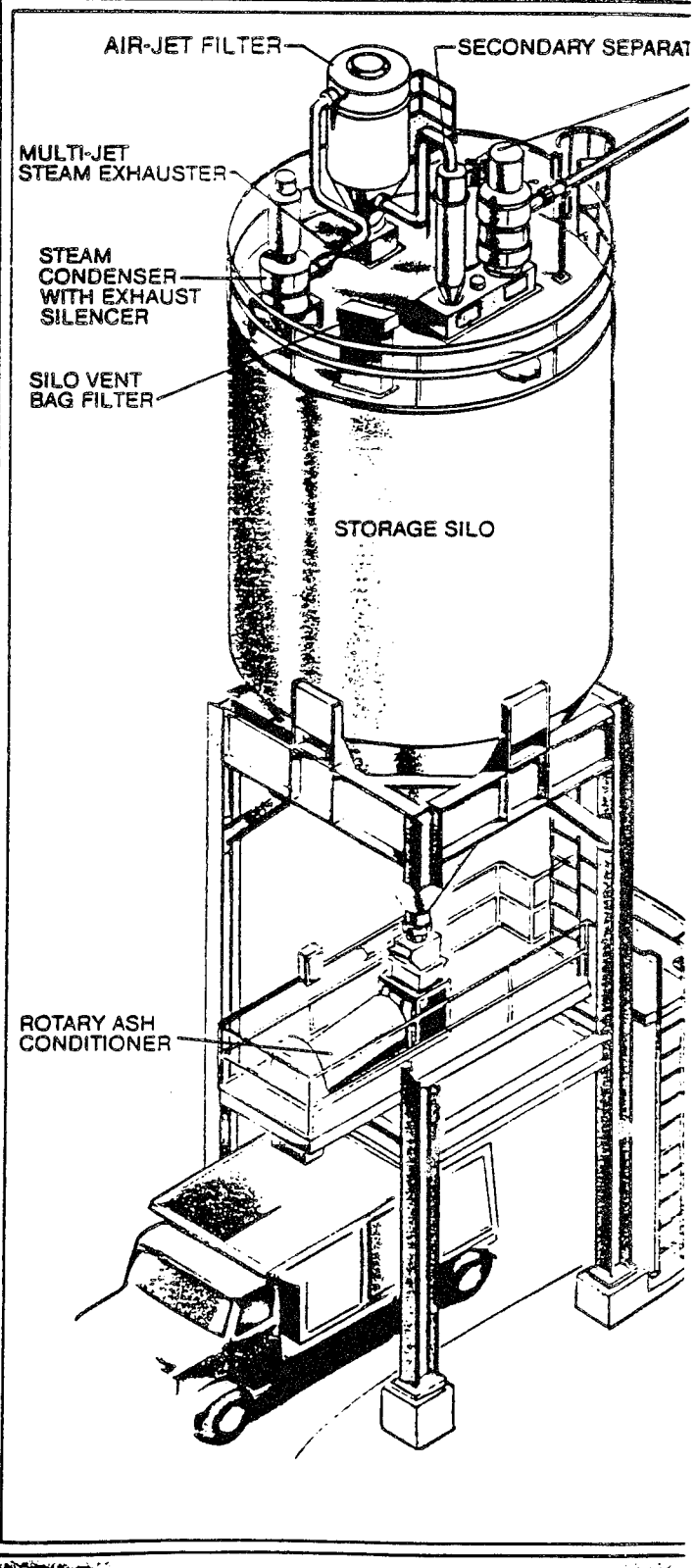
The design of the system insures that the ash storage silo is never placed under vacuum and that the ash is delivered to the silo in a dry state, since the steam does not come into contact with the ash either in the conveying duct or in the silo.

The ash pit hoppers are served with National vertical lifting doors, fitted with dust enclosures, which form a tight seal when closed. By effective design of the ash pit hopper, material can be gravity fed into the conveying system. If the firing of the boiler is such that a large amount of clinkers are anticipated, then a clinker grinder can be provided at this point, to automatically grind the bottom ash into particles small enough to insure trouble-free conveying.

Various fly ash collection points such as the siftings hopper, dust collector hoppers, precipitator hoppers, and baghouse hoppers are normally serviced with a fully enclosed swing type disc valve, proven to be the most effective and least costly type of valve for this service. All intake tees provided are of the offset self-feeding type, designed to prevent clogging.

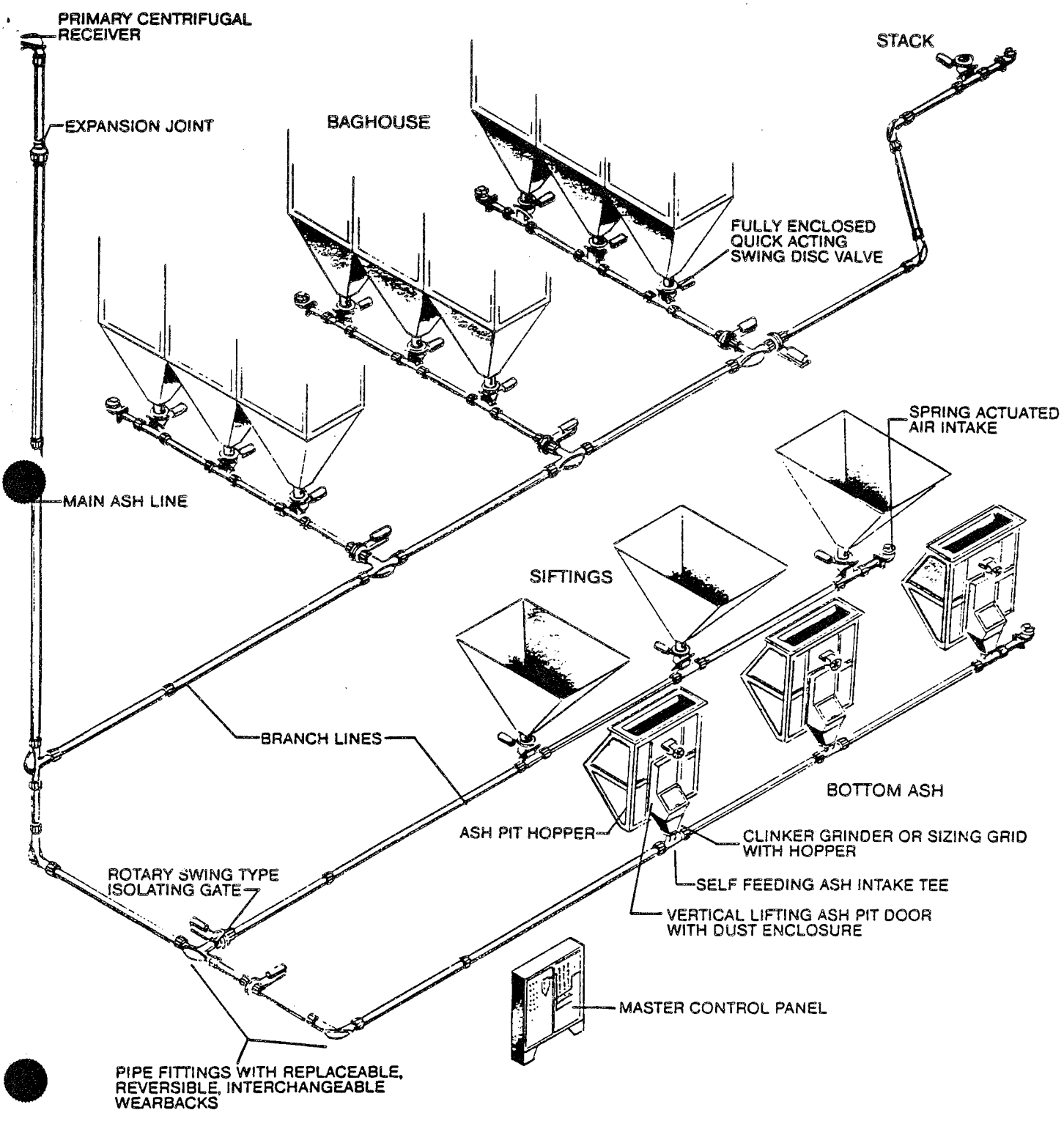
Depending upon preference, which is often dictated by the size and number of collection points involved, all of the fly ash collection points can be operated either manually or automatically with solenoid actuated air cylinders. Air cylinder operators permit remote manual operation from the control panel or automatic sequencing of the collection points. In the automatic sequential mode, the switching from one hopper to the next is effected by means of a vacuum switch, which is actuated when the hopper being served is no longer discharging material. Control panels are furnished complete with push buttons, indicating lamps, and vacuum gauges, as well as a graphic display which indicates at all times operation of the system and the collection point serviced.

The ash stored in the storage silo is discharge through a rotary ash conditioning unit to railroad cars or trucks. This unit moistens the ash or fly ash to a consistency that will permit its discharge and transport with no dust nuisance.



All National Conveyor pipe fittings, receiv
points of wear are cast with a hard alloy w
iron. Fittings are provided with replaceab
and interchangeable wearbacks. Inspection openings
and access ports are provided in fittings and com-
ponents in convenient locations throughout the system.
Major system components are illustrated on the fol-
lowing page.

a major supplier of pneumatic
ystems for handling ash and fly
ash. Systems designed and manufactured by
National decades ago, are still in use today in
many industrial and institutional power plants.
Find out more about National ash handling
systems and accessories.



finish shall be a 1 1/2 mil thick rust inhibitive primer over an SP-6 surface preparation. All O.E.M. supplied equipment will be furnished with their factory applied finish.

1.3 DRIVE UNIT: The drive station shall consist of a _____ horsepower, 460 volts, 3 phase, 60 hertz, T.E.F.C. motor, gear reducer, V-belt, sheaves, and sprockets which in combination give the proper belt speed for the load indicated. A single chain drive between reducer and sprocket shaft is to be provided for protection in case of sudden excessive overload conditions. The belt drive sheaves shall be interchangeable in order to provide a different speed by means of other size sheaves. Directly coupled drive motor-gear reducer combinations, without overload protection and speed change variability, shall not be acceptable.

2.0 OPTIONAL ACCESSORIES:

2.1 SKIRT BOARDS: A-36 Mild-steel skirt boards shall be provided at each loading area per dimensions shown on drawings.

2.2 DRIP PANS: Continuous galvanized steel drip pans (4 foot sections) shall be provided below the conveyor. The pans shall be sloped to drain as indicated on the drawings.

2.3 BELT SCRAPER: A pretensioned steel scraping mechanism to remove material constantly from the conveying surface shall be provided at the discharge end.

2.4 SPARE PARTS: One (1) set of spare parts shall be provided for the conveyor as recommended by the conveyor manufacturer.

3.0 FABRICATION AND INSTALLATION: All equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with detailed drawings, specifications, engineering data, instructions, and recommendations furnished by the equipment manufacturer. Final assembly of the entire conveyor unit may require the cutting and redrilling of some of the track sections in order to conform with any site deviations. This work shall be performed by the contractor on site.

4.0 FIELD TESTING: All of the conveyor, except for the conveyor belt section, shall be installed, adjusted, and operated, permission is to be provided by the belt pan manufacturer before belt pan sections can be installed.

5.0 FIELD SERVICE: The manufacturer's field engineer or representative shall be on hand to inspect and check the installation at the time of the initial start-up and operational testing of the equipment.

TECHNICAL SPECIFICATIONS
FOR
MODEL "I" CONVEYOR

1.0 CONVEYOR EQUIPMENT:

GENERAL: The conveyor equipment as supplied by Serpentix Conveyor Corporation, shall consist of conveyor belt pans, tracks and supports, take-up and drive stations. The conveyor shall be _____ long (centerline to centerline) with _____ inch wide belt pans and shall travel at _____F.P.M. Loading onto the conveyor shall be distributed evenly and shall not exceed a rate of _____. The conveyor shall have a watertight modular conveying surface with a 20 degree troughed cross section. Each modular conveying section shall have a convolution that permits the assembled belt to make continuous vertical, horizontal and helical turns and that will flatten out at it goes over the terminal, to allow for continuous belt cleaning with a pretensioned scraper bar. The modular belt pan section shall be reinforced with galvannealed steel stiffeners molded into each modular belt section to achieve troughing. The conveyor(s) will be so designed that all moving parts of the system, excepting the drive station and take-up stations, will pass a single designated point along the conveying path which may be used for maintenance and/or service of the unit(s).

1.1 CONVEYOR BELTS AND CHAIN: The conveying surface will consist of individually replaceable modular belt pan sections molded of neoprene-type rubber containing no less than a 60% chloroprene rubber content (certification test to be provided), fastened every eight (8) inches and supported by a steel attachment welded to a case-hardened steel chain having a minimum break strength of 32,000 pounds (certification test to be provided) that guides the conveying surface. Each modular belt pan section will have a convolution at least 1 1/2 inches high, permanently molded into the rubber. Deflector shield plates can be attached to the underside of the rubber belt pans, above the conveyor chain, to minimize entry of conveyed material into the polyethylene track. The dual flex steel chain links, with alternate single- and double-bars, will be joined by pins that are slightly loose in the single-bar link holes so the chain can be turned in two or more directions. The four (4) inch pitch steel chain will be guided by an ultra-high-molecular-weight polyethylene track (formed with minimum one (1) inch thick sides; 3/8 inch thick base and 5/8 inch thick top caps) that is permanently attached to a steel structure that also provides surfaces that can be utilized as contact surfaces for stabilizers to limit belt pan tipping in the event of unbalanced material loading.

1.2 TRACKS AND SUPPORTS: Track sections of required length shall be preassembled, ready for bolting where indicated. The conveyor track, of no less than seven (7) gauge thickness, and supports shall be steel and all structural steel members shall conform to A.S.T.M. A-36. All shop welding shall conform to the latest standards of the American Welding Society. All nuts, bolts, and washers shall be zinc plated steel. The take-up station shall consist of tail sprocket, take-up unit, and track all mounted in a structural frame and ready for installation. Factory

ROTO-WEIGH

Bulk In-Motion Electronic Weighing System

Roto-Weigh is a fully automatic, high capacity, continuous flow, weighing system with an accuracy of better than +0.1% for weighing bulk flowing materials such as coal, grain, raw sugar, metallic and non-metallic ores, chemicals, etc.

Roto-Weigh's patented design has combined the advantages of a conveyor scale with the accuracy of a Bulk Weighing System. The six models currently available, dependent upon the weight per cubic foot of the material, can weigh from 1 ton to 5000 tons per hour.

Roto-Weigh's unique design also provides simple dis-assembly if relocation of the weighing system becomes necessary.

Roto-Weigh utilizes a mini-computer for logic, processing of information and to actuate the weighing cycle and ancillary support equipment.

The Weighing Cycle Consists of:

Fig. #1 Top half of top bin being filled to pre-determined capacity.
Fig. #2 Utilizing gravity, the top bin rotates 180° dumping material into top half of lower weighing bin.
Fig. #3 Uninterrupted, the top bin is being filled. Bottom bin weighed.
Fig. #4 Top bin continues to be filled. Bottom bin rotates 180° dumping material and is positioned to receive material from top bin.
Fig. #5 Top bin continues to be filled. Bottom bin is tare weighed.

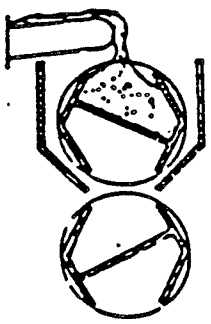
The tare weight is subtracted from the full weight and the difference (actual weight of the material delivered) is recorded and printed; also printed is the date, time of day weighing taken.

Roto-Weigh meets or exceeds performance requirements as specified in NBS Handbook H-44.

WEIGHING CYCLE

TOTAL ELAPSED TIME: 8 SECONDS

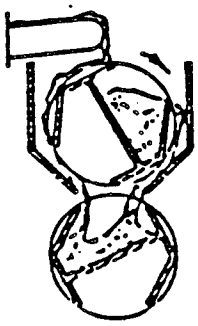
FIG. 1



TOP BIN
FILL CYCLE

BOTTOM BIN
TARE CYCLE

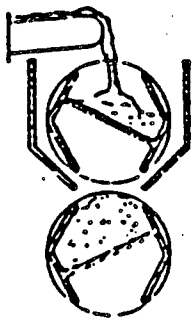
FIG. 2



TOP BIN
EMPTYING CYCLE

BOTTOM BIN
FILL CYCLE

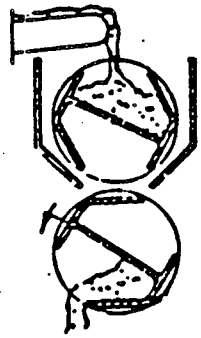
FIG. 3



TOP BIN
FILL CYCLE

BOTTOM BIN
WEIGH CYCLE

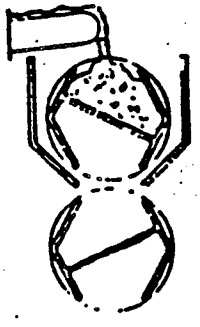
FIG. 4



TOP BIN
FILL CYCLE

BOTTOM BIN
EMPTYING CYCLE

FIG. 5

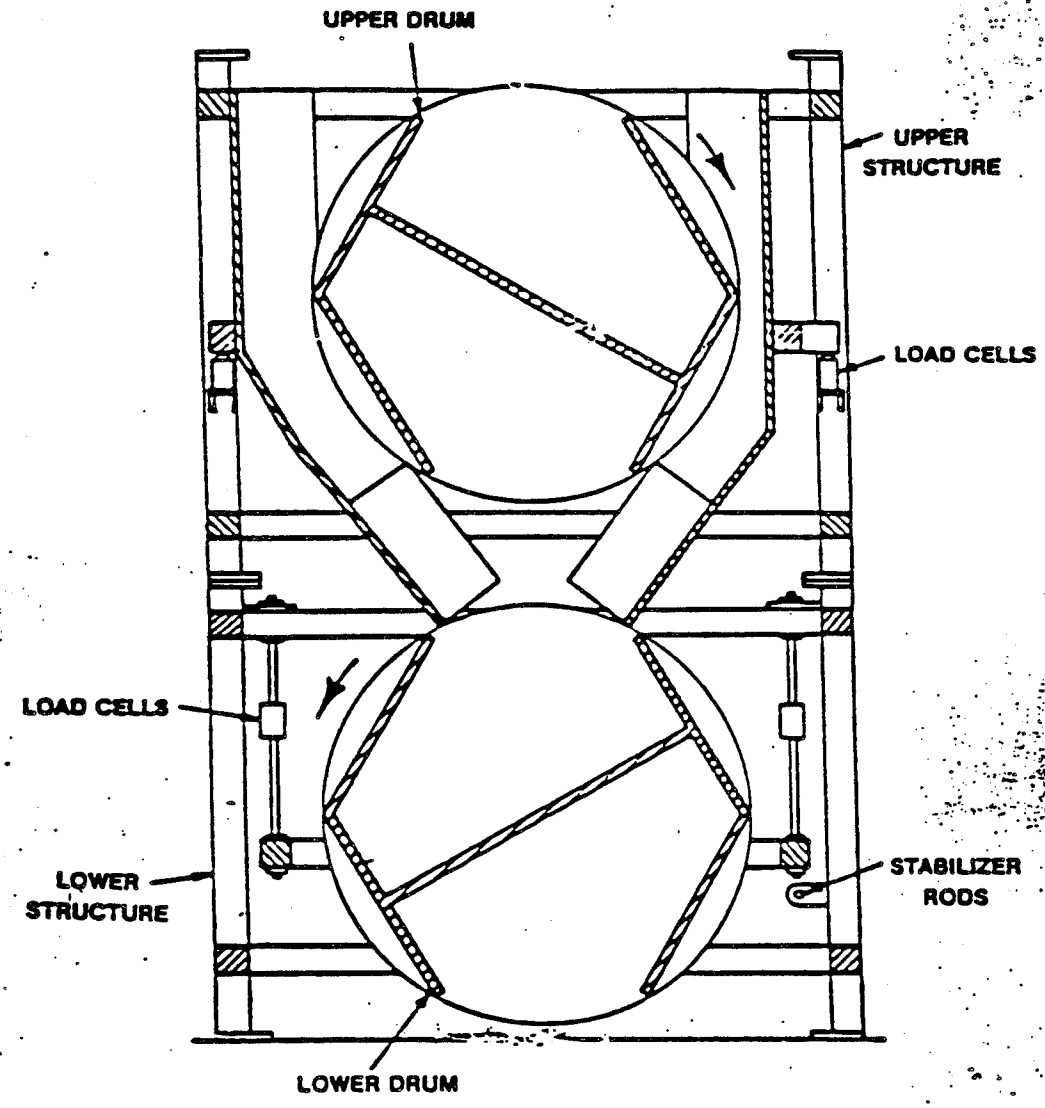


TOP BIN
FILL CYCLE

BOTTOM BIN
TARE CYCLE

ROTO-WEIGH

CONSTRUCTION



- SIMPLE DESIGN - GRAVITY OPERATED
- COMPLETELY AUTOMATED
- UNAFFECTED BY VIBRATION
- HEAVY TUBULAR CONSTRUCTION
- SAFETY ENGINEERED
- EASILY RELOCATED

[redacted]

ROTO-WEIGH SPECIFICATIONS

MACHINE #				
RW-1	Overall Height:	6'0"	Bin Capacity:	4.3 cu. ft.
	Overall Width:	4'0"	Shipping Weight:	6,523 lbs.
	Overall Length	4'0"	Bearing/Leg	1,845 lbs.
	Bin Diameter:	2'6"	Bearing/Place Dim.	12" x 12" x 1/2"
	Bin Length-upper	2'6"		
	lower	2'10"		
	With 10 sec. Cycle Minimum		1,548 cu. ft. per hour	
RW-5	Overall Height:	10'5"	Bin Capacity:	28 cu. ft.
	Overall Width:	6'7"	Shipping Weight:	10,523 lbs.
	Overall Length:	6'10"	Bearing/Leg	2,643 lbs.
	Bin Diameter:	4'6"	Bearing/Plate Dim.	12" x 12" x 1"
	Bin Length-upper	4'0"		
	lower	4'3"		
	With 10 sec. Cycle Minimum		10,080 cu. ft. per hour	
RW-10	Overall Height:	10'5"	Bin Capacity:	42 cu. ft.
	Overall Width:	6'7"	Shipping Weight:	15,515 lbs.
	Overall Length	8'10"	Bearing/Leg:	3,878 lbs.
	Bin Diameter:	4'6"	Bearing/Plate dim.	12" x 12" x 3/4"
	Bin Length-upper	6'0"		
	lower	6'5"		
	With 10 sec. Cycle Minimum		15,120 cu. ft. per hour	
RW-15	Overall Height:	13'3"	Bin Capacity:	86 cu. ft.
	Overall Width:	8'0"	Shipping Weight:	21,671 lbs.
	Overall length:	12'6"	Bearing/Leg:	5,418 lbs.
	Bin Diameter:	5'6"	Bearing/Plate Dim.	12" x 12" x 1"
	Bin Length-upper	9'4"		
	lower	9'10"		
	With 10 sec. Cycle Minimum		30,960 cu. ft. per hour	
RW-20	Overall Height:	16'10"	Bin Capacity:	154 cu. ft.
	Overall Width:	10' 1"	Shipping Weight:	25,895 lbs.
	Overall Length:	12' 9"	Bearing/Leg:	6,474 lbs.
	Bin Diameter:	7'7"	Bearing/Plate Dim.	12" x 12" x 1"
	Bin Length-upper	9'5"		
	lower	10'0"		
	With 10 sec. Cycle Minimum		55,440 cu. ft. per hour	
RW-30	Overall Height:	19'8½"	Bin Capacity:	300 cu. ft.
	Overall Width:	12'10"	Shipping Weight:	29,000 lbs.
	Overall Length:	12'0"	Bearing/Leg:	7,250 lbs.
	Bin Diameter:	9'0"	Bearing/Plate Dim.	12" x 12" x 1"
	Bin Length-upper	11'5"		
	lower	12'0"		
	With 10 sec. Cycle Minimum		108,000 cu. ft. per hour	

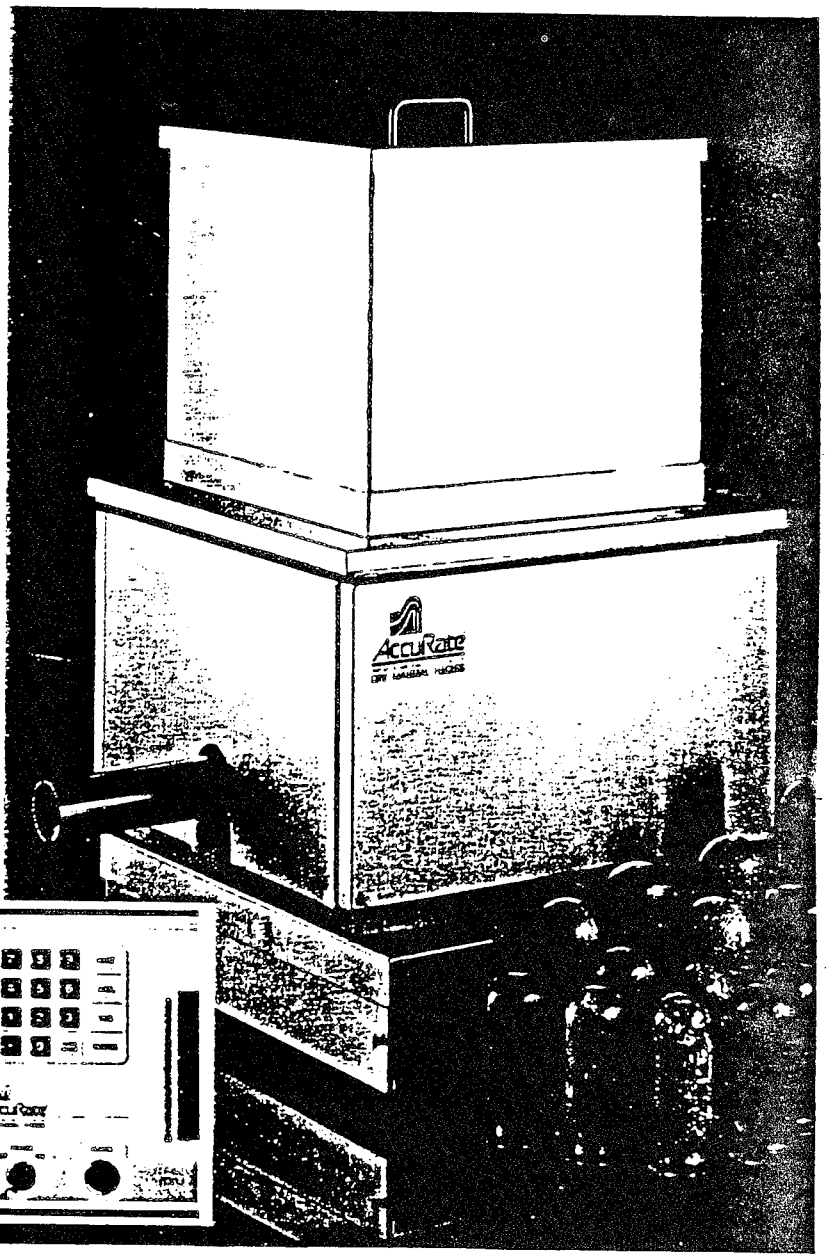
WELD 3900 FT³/HR

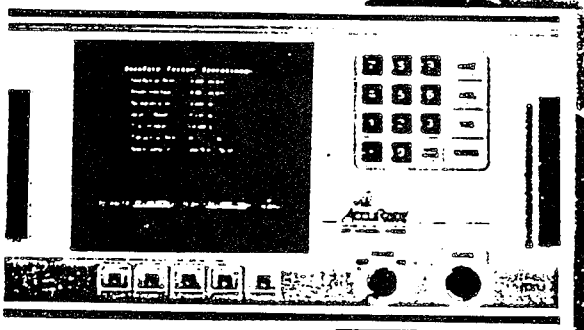
[redacted]

RW-40	Overall Height:	22'10½"	
	Overall Width:	12'0"	
	Overall length	12'9"	
	Bin Diameter:	10'	
	Bin Length-upper	11'5"	
	lower	12'0"	
	With 10 sec. Cycle Minimum		
			Bin Capacity: 375 cu. ft.
			Shipping Weight: 37,000 lbs.
			Bearing/Leg: 9,250 lbs.
			Bearing/Plage Dim. 18" x 18" x 1"
			135,000 cu. ft. per hour
RW-50	Overall Height:	24'10½"	
	Overall Width:	14'0"	
	Overall Length:	15'0"	
	Bin Diameter	11'	
	Bin Length-upper	11'5"	
	lower	13'0"	
	With 10 sec. Cycle Maximum		
			Bin Capacity: 455 cu. ft.
			Shipping Weight: 43,000 lbs.
			Bearing/Leg: 10,750 lbs.
			Bearing/Plage Dim. 18" x 18" x 1"
			163,000 cu. ft. per hour.

NEW FOR 1991!

You may not expect a Loss-In-Weight Feeder this advanced, this accurate, until 1991 . . . but it's here today! AccuRate is now offering Loss-In-Weight feeders, systems, and accessories that feature technology ahead of its time. If you need feeding accuracies of ± 1/4% to 1/2%*, and have a feed range between 1/2 and 750 lbs. per minute, the time has come for you to examine AccuRate.





Seeing Is Believing

Examine our feeder. Our time and test proven agitation system for conditioning material to a common density, while eliminating bridging problems, is standard on every model. Our scale is counterbalanced so only the material being fed is weighed. That assures greater accuracy. Most exciting is our control, a large 9" CRT screen that displays an easy-to-read and easily understood menu of operations . . . a control that is simple to program, with a list of parameters to fulfill most any feeding requirements.

Take a close look at our feeders. This is no Rube Goldberg concoction, piecemealed together and prone to breakdown. You see simple, but very effective engineering in a clean, compact package. In fact, each AccuRate Loss-In-Weight Feeder comes with a one-year warranty.

The Dry Material Specialist

If it's dry, we can feed it accurately. We offer a USDA-approved food and pharmaceutical model for sanitary applications, a corrosion-proof model for caustic materials and many other special variations.

AccuRate is ready to help you today. We'll even test your material in our new laboratory, free of charge. See for yourself the Loss-In-Weight of the future. You don't

AccuRate.

DRY MATERIAL FEEDERS

746 E. Milwaukee St.
Whitewater, WI 53190 USA
1-800-558-0184 (414) 473-2441
Telex 910 260 3832
Telefax 414 563 7437

AccuRate Europe N.V.
Stokt 1 2440 Geel Belgium
Telex 35462 Tel. 32 (014) 581750

* For most materials

GEAR MOTOR

RPM 45
HP ..... ¾
VOLTS 230/460
PHASE 3
CYCLES 60
MAKE ..... U.S. ELECTRIC
FRAME ..... 56-C.

MOTOR SUPPORT BRACKET
TYPE WS436-2R FOR RH MOUNTING
TYPE WS436-2L FOR LH MOUNTING

(8) ⅞ ϕ HOLES

PACKING GLAND.
PATT. NO. 948-1

OPENING FOR 1" STD. CONDUIT COUPLING

DRIVING SPROCKET
BORE 1⅛
KEYWAY ¼ x ⅛
NO OF TEETH 11

1-0 MIN - 1-11½ MAX

2-0½ MAX.

RC 60 SINGLE WIDTH ROLLER CHAIN

CHAIN GUARD

DRIVEN SPROCKET
BORE 1 2⅜
KEYWAY ⅝ x 5/16
NO. OF TEETH 17

FIG 5

CONDUIT CONN

FIG 1

GEARMOTOR MOUNTING POSITIONS

ALWAYS SPECIFY BY FIG. NO ON ORDER THE POSITION DESIRED.

1-1⅛

1-4⅛

HOUSING PATT NO. 1038

LINER PATT NO. 1041

ROTOR PATT NO. 1040

PACKING RINGS (3) 1½ I.D. - 2⅛ O.D. ⅛" SQ. ASBESTOS UNGRAPHITED JMC. #263

TAP & PLUG FOR FUTURE ALEMITE FITTING (IF REQUIRED)

1½ ϕ SHAFT

LINER LOCKING BOLT

JOHNSON GRAPHITED BRONZE BUSHING #KR 374

END PLATE - PATT No. 1039

OUTLET FLANGE SAME AS ABOVE

HOUSING PATT NO 1038-1

LINER PATT NO 1041

ROTOR PATT NO 1040

1-2½ DIA.

I.D. SECTION A-A

NOTE: FEEDER MOUNTING BOLTS ARE TO BE INSERTED TOWARD FEEDER WITH NUT BEARING ON FEEDER FLANGE. IF CLEARANCES DO NOT PERMIT THIS, USE STUD BOLTS WITH (8) NUTS FOR MOUNTING

GENERAL NOTES: (1) HOUSING, LINER & ROTOR CAST OF MACHINEABLE HARD IRON. (2) CAPACITY OF FEEDER = 45

NO	REVISIONS		
1	REVISED DIMENSIONS, ADDED #		
2	ADDED BEARING, ALEMITE FITTING NOTE	1-8-52	H.M.
3			

THIS DRAWING IN DESIGN AND DETAIL IS THE PROPERTY OF THE NATIONAL CONVEYORS CO., INC. AND MUST NOT BE USED OR COPIED IN CONNECTION WITH OUR WORK. ALL RIGHTS OF DESIGN AND INVENTION ARE RESERVED.

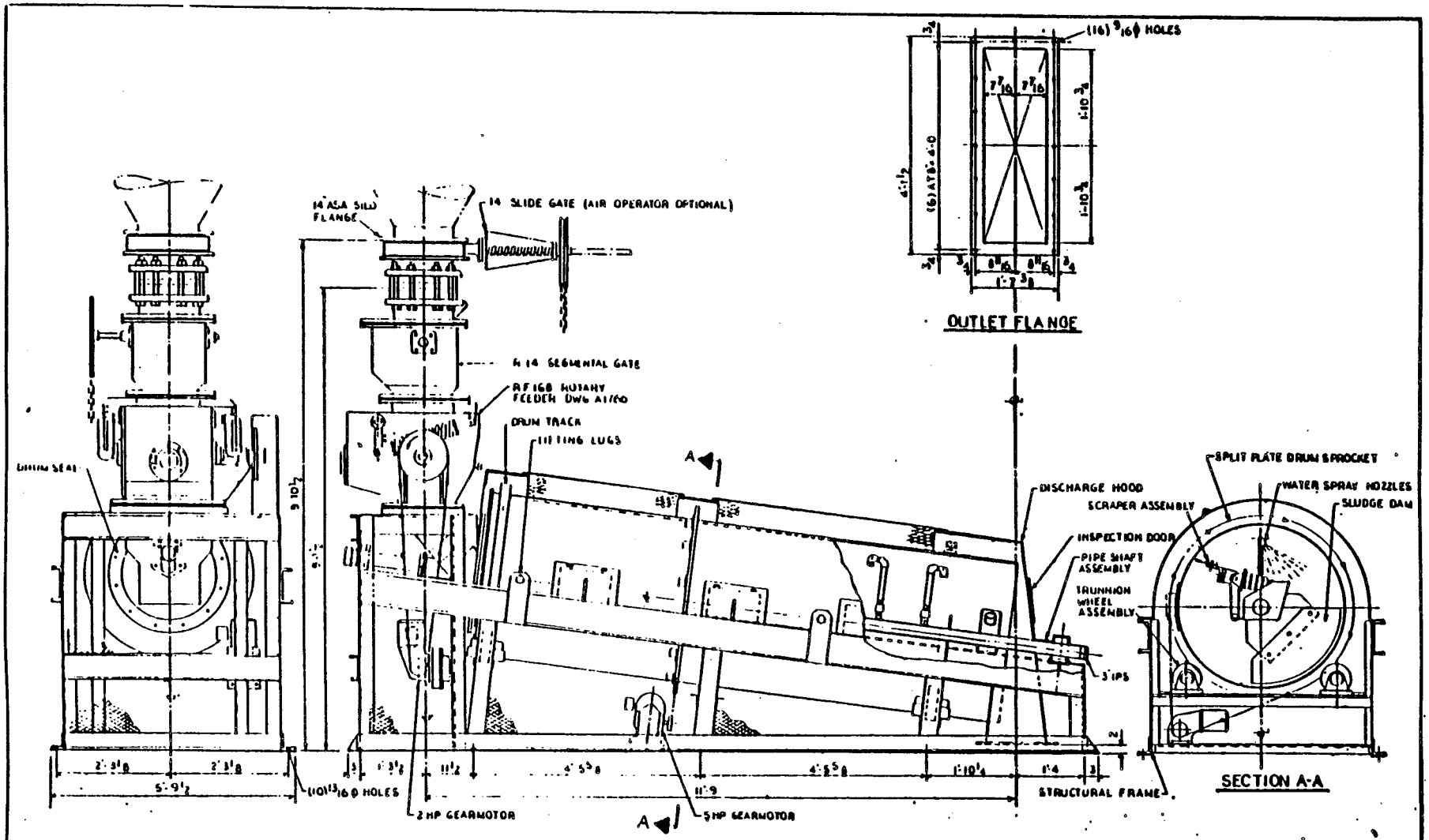
J.G. 7-16-51

NATIONAL CONVEYORS CO., INC

TYPE RV 45
ROTARY FEEDER

PRINT DRAWN 1-19-51

A 1 1 1 A



NO.	REVISIONS

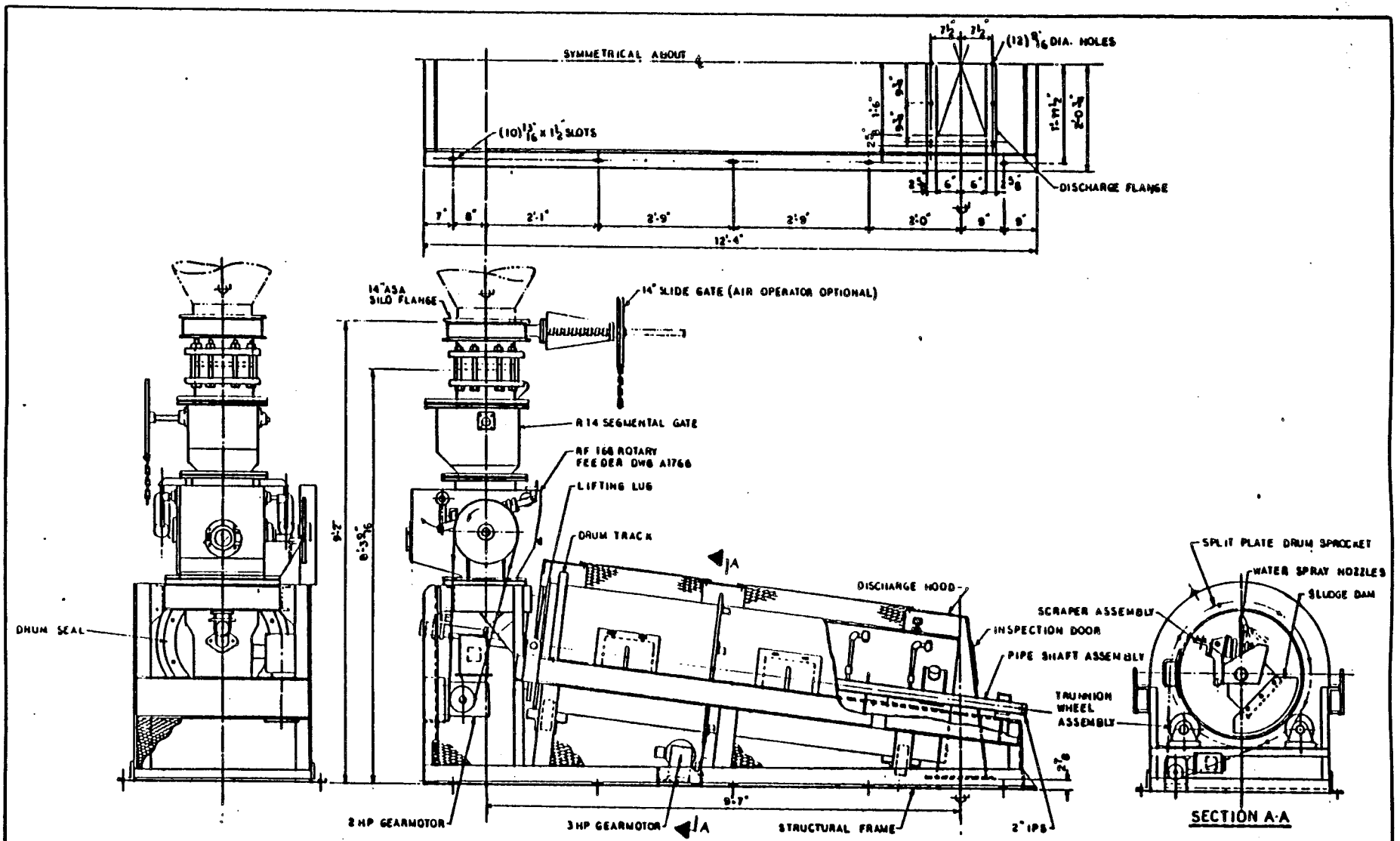
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DRAWN BY LF G DATE 10-6-81
TRACED BY JNG SCALE NONE
CHD BY GVG APP. AWP

NATIONAL CONVEYORS CO., INC.
FAIRVIEW, BERGEN COUNTY, NEW JERSEY

ASSEMBLY OF 38" TYPE RF ROTARY ASH CONDITIONER

PRINT ISSUED
DESTROY ALL PRINTS BEARING PREVIOUS DATES
3-17-82
DATE PREVIOUS ISSUE NONE
DRAWING NO.
A1304-3



NO.	REVISIONS

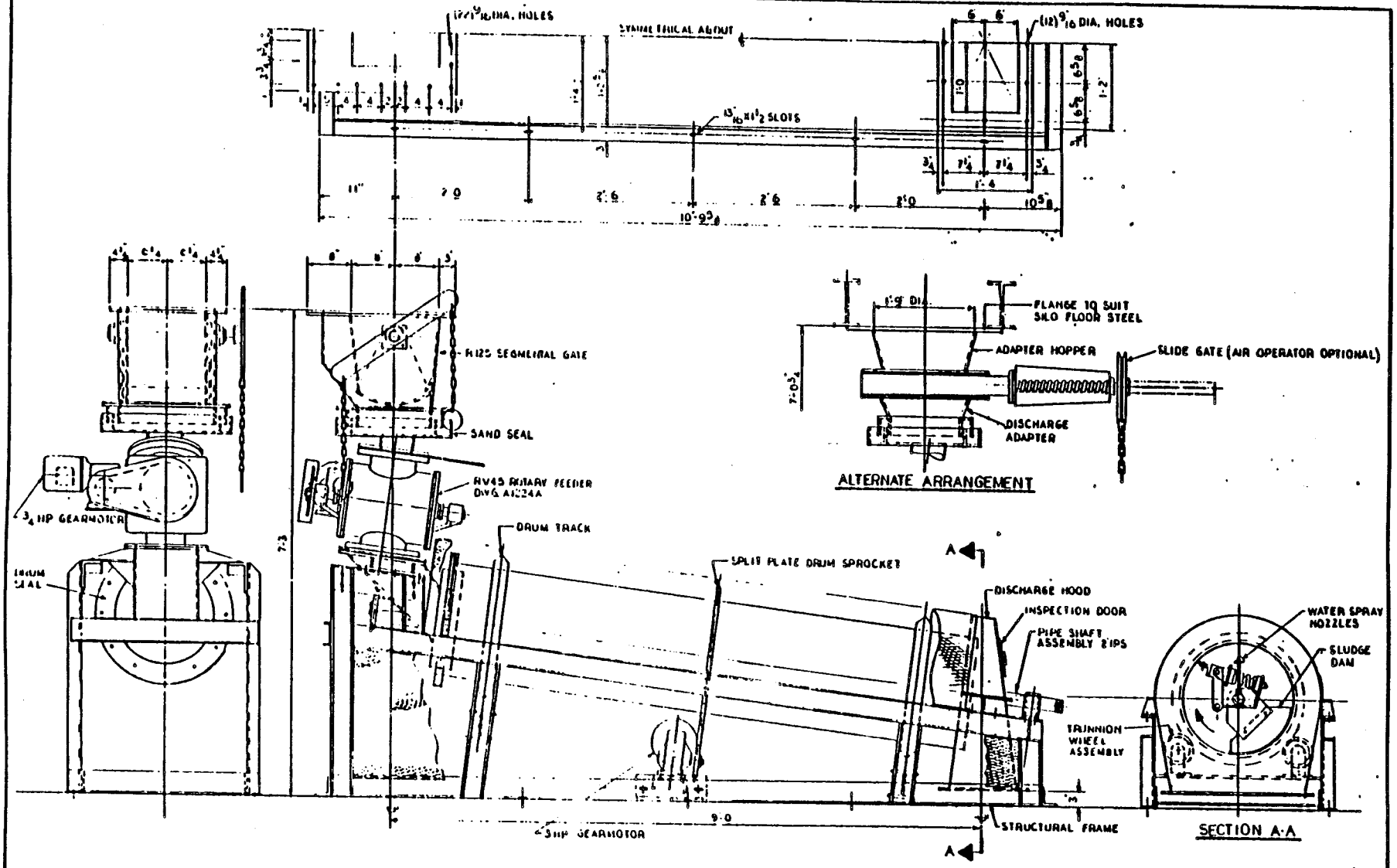
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DRAWN BY LFB DATE 10-14-81
TRACED BY JMC SCALE NONE
CHK BY CVG APP. AMP

NATIONAL CONVEYORS CO., INC.
FAIRVIEW, BERGEN COUNTY, NEW JERSEY

ASSEMBLY OF 30" TYPE RF ROTARY ASH CONDITIONER

PRINT ISSUED
DESTROY ALL PRINTS BEARING PREVIOUS DATES
3-17-82
DATE PREVIOUS ISSUE NONE
DRAWING NO.
A1449-2



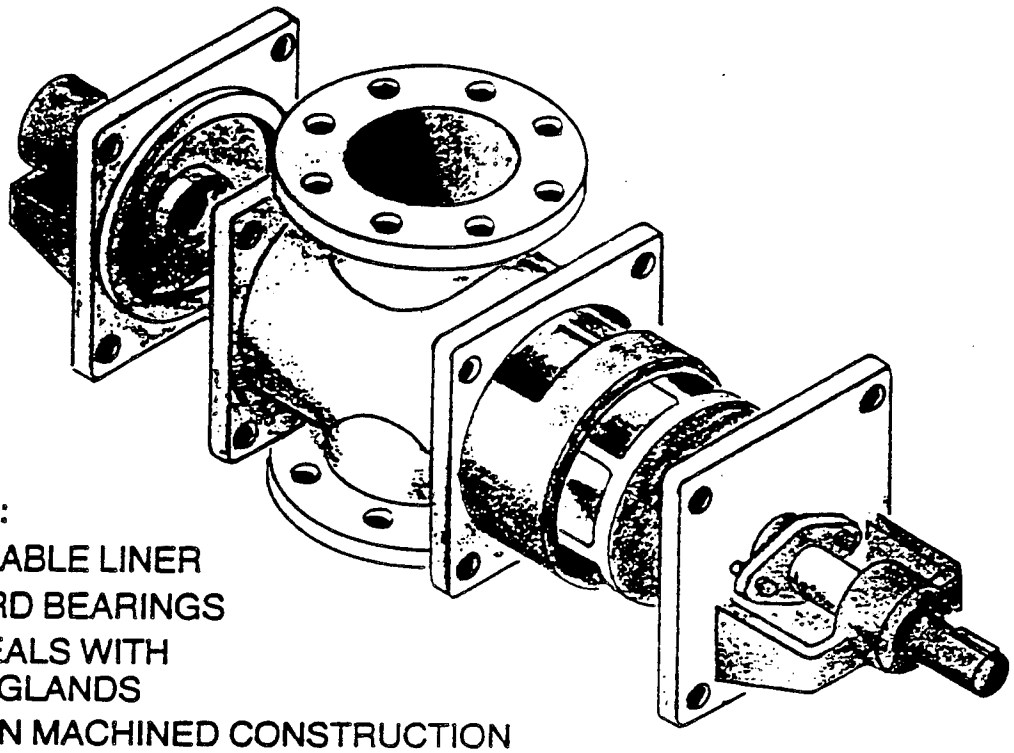
NO	REVISIONS	THIS DRAWING IN DESIGN AND DETAIL IS THE PROPERTY OF THE NATIONAL CONVEYORS CO., INC., AND MUST NOT BE USED EXCEPT IN CONNECTION WITH OUR WORK. ALL RIGHTS OF DESIGN AND INVENTION ARE RESERVED.	NATIONAL CONVEYORS CO., INC. FAIRVIEW, BERGEN COUNTY, NEW JERSEY	PRINT ISSUED DESTROY ALL PRINTS BEARING PREVIOUS DATES	M T W T F
		DRAWN BY RWD DATE 3-19-79	ASSEMBLY OF 20" TYPE RF ROTARY ASH CONDITIONER	10-6-79	
		TRACED BY SJG SCALE NONE		DATE PREVIOUS ISSUE NONE	
		CHD BY LFG APP. HJN		DRAWING NO. A1727	

National Conveyors

ROTARY FEEDERS

FOR ABRASIVE MATERIALS

SERVING INDUSTRY SINCE 1933



FEATURING:

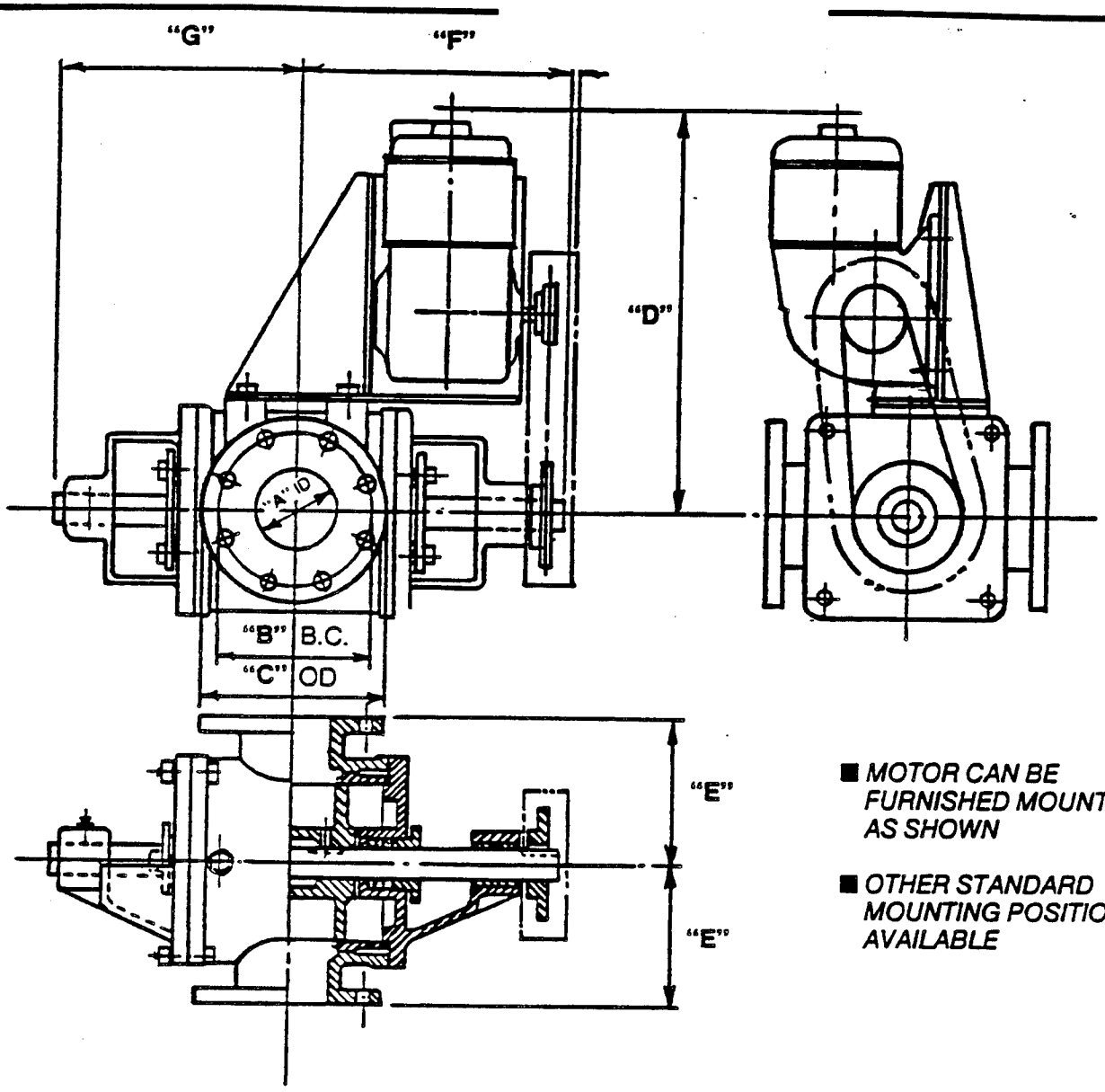
- — REPLACEABLE LINER
- — OUTBOARD BEARINGS
- — SHAFT SEALS WITH PACKING GLANDS
- — CAST IRON MACHINED CONSTRUCTION
- — CAPACITIES FROM 30 CFH TO 800 CFH
- — ON LINE REPLACEMENT CAPABILITY OF ALL INTERNALS

FURNISHED FULLY ASSEMBLED WITH OR WITHOUT DRIVE

NATIONAL CONVEYORS ALSO MANUFACTURES CAST IRON, STAINLESS STEEL AND SPECIALLY FABRICATED STEEL FEEDERS AND AIRLOCKS FOR THE METAL WORKING, ASH HANDLING, AND PLASTIC POLYMER INDUSTRIES. CONTACT US FOR ADDITIONAL INFORMATION AND PRICING

national CONVEYORS COMPANY INC.

FAIRVIEW, BERGEN COUNTY, NEW JERSEY



- *MOTOR CAN BE FURNISHED MOUNTED AS SHOWN*
- *OTHER STANDARD MOUNTING POSITIONS AVAILABLE*

MODEL	VOLUMETRIC ① CAPACITY IN FT³/HR (M³/HR)	A	B	C	D	E	F	G	HP	WT ②
RV 085	150 *(4.25)*	4 *(102)*	7½ *(190.5)*	9 *(229)*	15¾ *(400)*	7 *(178)*	13½ *(343)*	11¾ *(298)*	1/4	425 LBS *(193 kg)*
RV 122	220 *(7.1)*	6 *(152)*	9½ *(241.3)*	11 *(279)*	20⅜ *(518)*	7 *(178)*	15 *(381)*	13⅛ *(333)*	1/[illegible]	470 LBS *(213 kg)*
RV 45	800 *(22.6)*	8 *(203)*	11¾ *(298.5)*	13½ *(343)*	24½ *(622)*	9 *(229)*	16⅛ *(410)*	13⅞ *(352)*	3/4	550 LBS *(250 kg)*

DIMENSIONS IN ( ) ARE IN MILLIMETERS

① - Capacity based on maximum recommended RPM
② - Total weight of feeder, motor and drive package

NATIONAL CONVEYORS CO., INC.
25 Industrial Ave. Fairview, N.J. 07022 • (201) 945-9136 • TELEX: 12-9194 NatConvFavw

DEAN L. McNIVEN

Mc², Inc.

JAMES R. McFARLAND

March 30, 1987

HDR Environmental
8404 Indian Hills Drive
Omaha, NE. 68114

Attention: Randy Graycheck

Reference: Hazardous Waste Disposal Project

Attached is information describing the Roto-Weigh continuous bulk electronic weighing system. We think the Model RW-10 cost is about $95,000.00.

If the Roto-Weigh is of interest on your project, we will attempt to obtain more detailed information.

Mc2, Inc.

Jim McFarland
JRM:jk

Encl.

10922 "J" STREET • OMAHA, NEBRASKA 68137 • PHONE (402) 339-2212

National

conveyors company, inc.

(201) 945-9136
telex - 12-9194
nat conv fayvu

25 industrial avenue
fairview, new jersey 07022

March 13, 1987

HDR
8404 Indian Hills Drive
Omaha, Nebraska 68114

Att: Mr. Randy Grachek

Re: Component Information
Our Proposal No. A7561

Dear Mr. Grachek:

Enclosed please find Drawing A1224A which illustrates the rotary feeder included in the scope of our subject proposal.

In addition we have enclosed at your request, Drawings A1304-3; A1449-2, and A1727 illustrating our rotary ash conditioners.

Very truly yours,

NATIONAL CONVEYORS COMPANY, INC.

MAURICE GUGLIELMO, ENGINEER
MG:kk - Encl.

area code 201
new jersey—945-9136

area code 212
new york line—564-5974

National
conveyors company, inc.

25 industrial avenue
fairview, new jersey 07022

Proposal

NO. A7561

DATE FEBRUARY 17, 1987

TO: HDR
8404 INDIAN HILLS DRIVE
OMAHA, NEBRASKA 68114

ATTENTION: MR. RANDY GRACHEK

1. In accordance with specifications and conditions described herein, we propose to furnish, sell and deliver to you the following in good shipping order. The proposed material will be as regularly manufactured by our company, and will substantially conform to

the description below in accordance with your reference inquiry.

2. GENERAL DESCRIPTION AND SPECIFICATIONS

This proposal includes a screw conveyor, rotary valve, manual slide gates and motion detection switches in accordance with your inquiry.

GENERAL NOTES

1. To substantially reduce field installation and handling costs, all system components are factory assembled to the fullest extent possible.

   In addition to cost reduction, components are shop assembled prior to shipment to assure proper fit and operation.

2. The rugged design and high quality of the proposed equipment reflects over 50 years of experience in the field of conveying, storage, and unloading of ash and fly ash. We enclose copies of our bulletins A-83, C-83, C-1-72 and General Line Bulletin for your files.

3. We would be pleased to meet with you, at your convenience, to discuss this proposal in more detail and provide any additional information you might require.

CAPACITY

The equipment, when operated and maintained in accordance with our instructions will handle the specified 900CFH of fly ash based on a bulk density of 60 lbs. per cu. ft.

SPECIAL CONSTRUCTION FEATURES

The screw conveyor included for this offering incorporates the following special construction features to insure long life with minimum maintenance.

A - Sectional (constant thickness) flighting of abrasion resistant metal, minimum Brinnel hardness of 225.
B - Continuous welding of flights to pipe shaft on carrying side of conveyor.
C - Cold rolled steel shafting.
D - Quick detachable connections at shafts.
E - Hardened coupling bolts.
F - Hercules tapered fasteners at coupling bolts to prevent elongation and premature wear at connections.
G - Expansion bearing opposite drive end.
H - Dust tight shaft seals.
J - Gasketed flange for connection to precipitator hopper.
K - Flared trough, abrasion resistant steel with minimum Brinnel hardness of 225.
L - Oversize motor and drive components.

SPECIAL CONSTRUCTION FEATURES (Con't)

Our rotary feeder, as described in the enclosed flyer, is specifically designed for abrasive fly ash service and includes the following design features.

M - Replaceable liner to preclude housing wear. This feature allows replacement of the feeder internals without removal of the housing from its installation location.
N - Outboard bearings.
P - Shaft seals with externally adjustable packing glands.
Q - Integrally mounted motor and roller chain drive.
R - Shrouded rotor.

BILL OF MATERIAL

1 - Helicoid conveyor, 14" dia., 50'-0" approximate overall length complete with the following:

1 - Trough, cover, and boxes shaft seals with anti-friction bearings, and 14" dia. extra heavy helicoid section with abrasion resistant flights continuously welded on carrying side.

1 - 5 HP, 1800 RPM, TEFC, gearmotor.

1 - Finished steel roller chain drive from output shaft of gearmotor to helicoid feeder drive shafts, with guard.

1 - Motor detection limit switch assembly.

2 - 14" dust tight flat slide, rack and pinion gate with handwheel operator.

1 - 12" x 8" transition chute, 1/4" thick steel construction.

1 - National RV45 rotary airlock feeder complete with 1 HP, TEFC gearmotor drive and motion detection limit switch assembly.

1 - Lot, necessary bolts, nuts and gasket material for assembly of above.

3. DRAWINGS

We will furnish a complete set of general arrangement drawings within 10 days after receipt of order.

These specifications and any drawings accompanying them are our property and are subject to recall at any time before this proposal becomes a contract. Any drawings accompanying this proposal are not to be used for construction purposes.

4. DELIVERY

We agree to ship in approximately within 12 weeks from date of final approval of this proposal, receipt of information necessary to prosecute the work, and prompt approval of drawings by you.

5. GUARANTEE

When operated in accordance with our instructions, we guarantee this system to be in full accordance with the purpose for which it was designed, and to be free from any inherent defects. We will replace at no charge any defective parts, returned f.o.b. our shops, within one year from date of shipment. *

6. PURCHASER TO FURNISH

a) All erection labor and supervision of erection. (See Par. 9 for per diem rate for services of our superintendent);

b) Unloading and storage of equipment;

c) Field painting, if required;

d) All electric controls, electric wiring and conduit;

e) Proper lubrication of all equipment, prior to start-up;

f) Flange connections to suit our equipment;

g) All pipe and valve support hangers;

and all other items not listed above in our BILL OF MATERIAL.

* Upon notification, our procedure is to send a representative to determine whether return is necessary, or if corrective action can be made at the jobsite.

7. **PURCHASE PRICE AND TERMS OF PAYMENT**

For furnishing the equipment as listed in our **BILL OF MATERIAL**, we are pleased to quote as follows:

Equipment	$23,625.00
Freight to Denver, Colorado	$ 1,260.00
Total	$24,885.00

The above price is f.o.b. our shops Fairview, New Jersey and other shipping points. Freight to Denver, Colorado is listed separately.

TERMS

Our terms are Net within 30 days on partial billings as shipments are made.

8. The prices quoted are firm for acceptance within 30 days, unless otherwise specified.

9. SERVICE OF SUPERINTENDENT

Services of our superintendent are available to supervise and check the installation and place the entire equipment into regular operation.

Time or trips will be charged at the rate of $ 320.00 per 8-hour working day, plus travel time and expenses. If the working day exceeds 8 hours, additional hours will be payable at the regular overtime rate.

10. PAINTING

We will apply one coat of paint to all structural and plate work, and also shall grease or oil all exposed finished parts of machinery before shipment.

11. SAFETY DEVICES

We will supply such safety devices as may be specified in this proposal, but, excepting these, we shall not be required to supply or install any safety devices, whether specified by law or otherwise.

12. PATENTS

We agree to hold the purchaser harmless against any claim of infringement of any U.S. patent now issued involving exclusively apparatus actually sold and designed by National Conveyors Company, Inc. and charging exclusively infringement of any mechanical apparatus claim of said patent provided we are immediately notified in writing upon receipt of such claim, are given absolute control of the defense with the right to defend or settle, and are allowed to make changes in the equipment for the purpose of avoiding infringment, it being agreed that the obligation above set out is the only obligation of National Conveyors Company, Inc. with respect to any claim of patent infringement.

13. DRAYAGE

Unloading and storage of material; unloading material between points of delivery by truck, rail or water transportation lines and site of erection is not provided for by this contract, and if required, must be done by Purchaser. Purchaser agrees to provide shelter and be responsible for safe keeping of equipment covered by this proposal until erected.

14. CANCELLATION

Cancellation or suspension of this order will be accepted only upon terms that will indemnify the National Conveyors Company, Inc. against loss.

15. TAXES

All prices will be increased to the extent of any excise, sales, gross receipts, use or occupational tax or other similar tax which the seller may be obliged to pay on account of this transaction.

16. CHANGES AND DELAYS

If you cause changes to be made, or delay or interrupt the progress of the work, you are to reimburse us for any additional expense, or we are to credit you for any reduced cost, which can be established as resulting from such causes.

17. LIABILITY

We are not to be held liable for any loss, damage or delay due to transportation, accident, fire, strike, civil or military authority, insurrection, or any causes beyond our control.

18. CLAIMS

We will consider no claim for shortage or errors unless such claim is made immediately after receipt of shipment.

19. TITLE AND OWNERSHIP

It is the intent of this proposal that the machinery described herein be sold to you, and that title for same shall be acquired by you when final payment therefor in cash is made. We intend to give you possession before the final payment is due, and so to protect us against default in payment, or, in the event that an execution, attachment or other writ be levied on your property, it is hereby expressly understood that:

(a) The title and right of possession to the machinery equipment covered by this proposal shall remain with us until full and final payment therefor in cash shall have been made in accordance with the terms agreed upon. In the event of default in any payments herein provided for, we may repossess ourselves of the within specified ma-

chinery equipment, and all additions thereto, wherever found, free from all claims whatsoever, or assert a mechanic's lien, and we shall not be held liable, in any action at law on your part, for such reclamation, nor for the repayment of any money which may have been paid by you in part payment for said machinery equipment.

(b) No part of machinery furnished under this proposal shall be considered a fixture or incorporated into the realty by reason of its being attached to real estate, and any part may be separated from such real estate for purpose of repossession by us or our agents without liability for such removal on our part, if you have defaulted in payment of the purchase money.

(c) We shall have the right to elect to assert our claim of a mechanic's lien against the property upon which the machinery is erected and waive our right to repossess the machinery under paragaphs (a) and (b) above, any time before the expiration of the time fixed by law for filing a mechanic's lien.

20. INSURANCE

Upon shipment of the equipment covered by the contract, the Purchaser shall procure at his expense, and maintain for the benefit of both parties, adequate insurance against loss or damage.

21. ACCEPTANCE

This proposal is for your signature; please sign and return it to us. In the event that you also submit your own purchase form, it will be necessary that you state thereon that "Purchaser accepts all terms and conditions in seller's Proposal No. A7561 dated 2/17/87 ," and any related addendums, stating addendum number and date.

22. The preceding terms and conditions shall be a part of any contract of sale which may be entered into between the Buyer and National Conveyors Co., Inc., based on this proposal. No terms and conditions in Buyer's purchase order, which are at variance with the terms and conditions of this proposal, will be acceptable to us or become a part of any resulting contract without the written authorization of the executive officer of our company. Neither acknowledgement and return of a copy of Buyer's purchase order or other form, irrespective of its terms, nor the filling and shipment of such order, shall constitute acceptance of such conflicting, inconsistent or additional terms, nor shall they in any way operate to modify, or change the full effect of the terms and conditions herein.

23. There are no agreements or verbal understandings outside of this proposal. The foregoing shall become a contract agreement only when accepted by you as Purchaser, and approved in writing by the executive officer of our company.

Respectfully submitted,

National conveyors company, inc.

By HARRY J. MANZIONE, PRESIDENT
HJM/jb
Encl.

To the National conveyors company, inc.

Your proposal as above is hereby accepted this ..... day

of ..... 19 .....

By .....

(TITLE)

National

conveyors company, inc.

(201) 945-9136
telex - 12-9194
nat conv fayc

25 industrial avenue
fairview, new jersey 07022

February 17, 1987

HDR
8404 Indian Hills Drive
Omaha, Nebraska 68114

Attention: Mr. Randy Grachek

Re: Our Proposal A7561

Dear Mr. Grachek,

We are pleased to enclose our proposal based on your telephone conversation with our Mr. Arnold Serenkin.

We trust this fulfills your present needs and we look forward to receiving your valued order. If your have any questions, or if we can provide you with additional information, please do not hesitate to contact us.

Thanking you, we remain

Very truly yours,

NATIONAL CONVEYORS COMPANY, INC.

MAURICE GUGLIELMO, ENGINEER

MG/jb
Encl.

ART ASH RESEARCH & TESTING, INC.

87 SOUTH BRENTWOOD STREET • LAKEWOOD, COLORADO 80226 • PHONE 303-237-4644

ASTM C 618 - FLY ASH AND RAW OR CALCINED NATURAL POZZOLAN FOR USE AS A MINERAL ADMIXTURE IN PORTLAND CEMENT CONCRETE

Sample Comanche #70 Date 10-16-86 Client Rocky Mountain Ash Company
Client Identification 400 ton composite sample August 5 to September 17, 1986
Date Received 9-26-86 ASTM C 618-80 Classification C

CHEMICAL TESTS

REQUIRED			OPTIONAL	
Oxide Analysis (%)			Oxide Analysis (%)	
Silicon dioxide	27.99		Available alkalies (28-day @ 100°F	
Aluminum oxide	18.13		Sodium oxide	0.68
Iron oxide	4.16		Potassium oxide	0.16
TOTAL (SiO_2, Al_2O_3, Fe_2O_3)	50.28	50.0 Min	TOTAL as Na_2O	0.79
Sulfur trioxide	2.20	5.0 Max	1.5 Maximum	
			OTHER	
Loss on Ignition (%)	0.40	6.0 Max	Total Alkalies (%)	
Moisture Content (%)	0.06	3.0 Max	Sodium oxide	1.10
			Potassium oxide	0.20
OTHER			TOTAL as Na_2O	1.23
Calcium Oxide (%)	30.60			

PHYSICAL TESTS

REQUIRED			OPTIONAL	
Retained on #325 Sieve	12.6 %	34 Max	Reactivity with cement alkalies	
Specific Gravity	2.72		Mortar expansion (14 days)	%
Pozzolanic activity index			0.020 Maximum	
28-day % of control	83.5 %	75 Min	Increase of drying shrinkage	
Water requirement	89.6 %	105 Max	of mortar bars @ 28 days	%
Water-cementitious ratio	0.474	-	0.03 Maximum	
Autoclave expansion	0.135 %	0.8 Max	Uniformity requirement	
Normal Consistency	22.9 %	-	Variation in quantity of	
Uniformity requirements (% variation)			air entraining agent	%
Specific Gravity	0.85 %	5.0 Max	20% Maximum	
Retained on #325 Sieve	1.37 %	5.0 Max		

OTHER
Pozzolanic activity index
7-day % of control 79.4 %

A. C. Masbruch
Laboratory Manager

ART ASH RESEARCH & TESTING, INC.

87 SOUTH BRENTWOOD STREET • LAKEWOOD, COLORADO 80226 • PHONE 303-237-4644

ASTM C 618 - FLY ASH AND RAW OR CALCINED NATURAL POZZOLAN FOR USE AS A MINERAL ADMIXTURE IN PORTLAND CEMENT CONCRETE

Sample Wheatland #33 Date 11-12-86 Client Rocky Mountain Ash Company
Client Identification 400 ton composite sample, October 23 to October 30,1986
Date Received 10-31-86 ASTM C 618-85 Classification C

CHEMICAL TESTS

REQUIRED			OPTIONAL	
Oxide Analysis (%)			Oxide Analysis (%)	
Silicon dioxide	33.28		Available alkalies (28-day @ 100	
Aluminum oxide	20.19		Sodium oxide	1.03
Iron oxide	5.34		Potassium oxide	0.22
TOTAL (SiO_2, Al_2O_3, Fe_2O_3)	58.81	50.0 Min	TOTAL as Na_2O	1.17
Sulfur trioxide	2.30	5.0 Max	1.5 Maximum	
			OTHER	
Loss on Ignition (%)	0.45	6.0 Max	Total Alkalies (%)	
Moisture Content (%)	0.03	3.0 Max	Sodium oxide	1.74
			Potassium oxide	0.34
OTHER			TOTAL as Na_2O	1.96
Calcium Oxide (%)	27.49			

PHYSICAL TESTS

REQUIRED			OPTIONAL	
Retained on #325 Sieve	13.5 %	34 Max	Reactivity with cement alkalies	
Specific Gravity	2.68		Mortar expansion (14 days)	
Pozzolanic activity index			0.020 Maximum	
28-day % of control	114.0 %	75 Min	Increase of drying shrinkage	
Water requirement	88.5 %	105 Max	of mortar bars @ 28 days	
Water-cementitious ratio	0.467	-	0.03 Maximum	
Autoclave expansion	0.075 %	0.8 Max	Uniformity requirement	
Normal Consistency	22.9 %	-	Variation in quantity of air entraining agent	
Uniformity requirements (% variation)			20% Maximum	
Specific Gravity	0.56 %	5.0 Max		
Retained on #325 Sieve	1.35 %	5.0 Max		

OTHER
Pozzolanic activity index
7-day % of control 110.

A. C. Masbruch
Laboratory Manager

ART ASH RESEARCH & TESTING, INC.

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ASTM C 618 - FLY ASH AND RAW OR CALCINED NATURAL POZZOLAN FOR USE AS A MINERAL ADMIXTURE IN PORTLAND CEMENT CONCRETE

Sample Pawnee #89 Date 11-12-86 Client Rocky Mountain Ash Company
Client Identification 400 ton composite sample, October 6 to October 15, 1986
Date Received 10-17-86 ASTM C 618-85 Classification C

CHEMICAL TESTS

REQUIRED			OPTIONAL	
Oxide Analysis (%)			Oxide Analysis (%)	
Silicon dioxide	32.82		Available alkalies (28-day @ 100°F)	
Aluminum oxide	19.72		Sodium oxide	0.97
Iron oxide	4.98		Potassium oxide	0.15
TOTAL (SiO_2, Al_2O_3, Fe_2O_3)	57.52	50.0 Min	TOTAL as Na_2O	1.07
Sulfur trioxide	2.17	5.0 Max	1.5 Maximum	
			OTHER	
Loss on Ignition (%)	0.35	6.0 Max	Total Alkalies (%)	
Moisture Content (%)	0.05	3.0 Max	Sodium oxide	1.47
			Potassium oxide	0.33
OTHER			TOTAL as Na_2O	1.69
Calcium Oxide (%)	26.75			

PHYSICAL TESTS

REQUIRED			OPTIONAL	
Retained on #325 Sieve	13.5 %	34 Max	Reactivity with cement alkalies	
Specific Gravity	2.70		Mortar expansion (14 days)	%
Pozzolanic activity index			0.020 Maximum	
28-day % of control	108.4 %	75 Min	Increase of drying shrinkage	
Water requirement	87.7 %	105 Max	of mortar bars @ 28 days	%
Water-cementitious ratio	0.463	-	0.03 Maximum	
Autoclave expansion	0.103 %	0.8 Max	Uniformity requirement	
Normal Consistency	22.8 %	-	Variation in quantity of air entraining agent	%
Uniformity requirements (% variation)			20% Maximum	
Specific Gravity	0.70 %	5.0 Max		
Retained on #325 Sieve	0.55 %	5.0 Max		

OTHER
Pozzolanic activity index
7-day % of control 104.8 %

A. C. Masbruch
Laboratory Manager

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ASTM C 618 - FLY ASH AND RAW OR CALCINED NATURAL POZZOLAN FOR USE AS A MINERAL ADMIXTURE IN PORTLAND CEMENT CONCRETE

Sample Cherokee #55 Date 10-16-86 Client Rocky Mountain Ash Compan
Client Identification 400 ton composite sample September 18 to October 3, 1986
Date Received 10-7-86 ASTM C 618-80 Classification F

CHEMICAL TESTS

REQUIRED			OPTIONAL	
Oxide Analysis (%)			Oxide Analysis (%)	
Silicon dioxide	58.59		Available alkalies (28-day @ 100	
Aluminum oxide	27.12		Sodium oxide	0.51
Iron oxide	2.91		Potassium oxide	0.26
TOTAL (SiO_2, Al_2O_3, Fe_2O_3)	88.62	70.0 Min	TOTAL as Na_2O	0.66
Sulfur trioxide	0.27	5.0 Max	1.5 Maximum	
			OTHER	
Loss on Ignition (%)	0.62	6.0 Max	Total Alkalies (%)	
Moisture Content (%)	0.09	3.0 Max	Sodium oxide	0.81
			Potassium oxide	1.09
			TOTAL as Na_2O	1.53
OTHER				
Calcium Oxide (%)	5.09			

PHYSICAL TESTS

REQUIRED			OPTIONAL	
Retained on #325 Sieve	24.9 %	34 Max	Reactivity with cement alkalies	
Specific Gravity	2.11		Mortar expansion, 14 days	
Pozzolanic activity index			0.020 Maximum	
28-day % of control	95.2 %	75 Min	Increase of drying shrinkage	
Water requirement	98.8 %	105 Max	of mortar bars @ 28 days	
Water-cementitious ratio	0.562	-	0.03 Maximum	
Autoclave expansion	-0.016 %	0.8 Max	Uniformity requirement	
Normal Consistency	26.5 %	-	Variation in quantity of	
Uniformity requirements (% variation)			air entraining agent	
Specific Gravity	0.23 %	5.0 Max	20% Maximum	
Retained on #325 Sieve	2.15 %	5.0 Max		
Pozzolanic index with Lime (2" cube method)	1035 psi		OTHER	
			Pozzolanic activity index 7-day % of control	75

G. C. Bamberger
A. C. Mesenbrink
Laboratory Manager

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ASTM C 618 - FLY ASH AND RAW OR CALCINED NATURAL POZZOLAN FOR USE AS A MINERAL ADMIXTURE IN PORTLAND CEMENT CONCRETE

Sample Nixon #43 Date 10-16-86 Client Rocky Mountain Ash Company
Client Identification 400 ton composite sample - September 10 to September 23, 1986
Date Received 9-28-86 ASTM C 618-80 Classification F

CHEMICAL TESTS

REQUIRED			OPTIONAL	
Oxide Analysis (%)			Oxide Analysis (%)	
Silicon dioxide	59.54		Available alkalies (28-day @ 100	
Aluminum oxide	26.23		Sodium oxide	0.57
Iron oxide	3.77		Potassium oxide	0.43
TOTAL (SiO_2, Al_2O_3, Fe_2O_3)	89.54	70.0 Min	TOTAL as Na_2O	0.85
Sulfur trioxide	0.32	5.0 Max	1.5 Maximum	
			OTHER	
Loss on Ignition (%)	0.96	6.0 Max	Total Alkalies (%)	
Moisture Content (%)	0.10	3.0 Max	Sodium oxide	0.90
			Potassium oxide	1.23
OTHER			TOTAL as Na_2O	1.72
Calcium Oxide (%)	4.25			

PHYSICAL TESTS

REQUIRED			OPTIONAL	
Retained on #325 Sieve	24.8 %	34 Max	Reactivity with cement alkalies	
Specific Gravity	2.19		Mortar expansion (14 days)	
Pozzolanic activity index			0.020 Maximum	
28-day % of control	103.4 %	75 Min	Increase of drying shrinkage	
Water requirement	96.4 %	105 Max	of mortar bars @ 28 days	
Water-cementitious ratio	0.541	-	0.03 Maximum	
Autoclave expansion	-0.024 %	0.8 Max	Uniformity requirement	
Normal Consistency	27.1 %	-	Variation in quantity of	
Uniformity requirements (% variation)			air entraining agent	
Specific Gravity	0.04 %	5.0 Max	20% Maximum	
Retained on #325 Sieve	2.26 %	5.0 Max		
Pozzolanic Index with Lime (2" cube method)	1105 psi		OTHER	
			Pozzolanic activity index 7-day % of control	87.1

A. C. Masbruch
Laboratory Manager

ROCKY MOUNTAIN ASH COMPANY

4380 S. SYRACUSE ST., SUITE 305 • DENVER, CO 80237 (303) 779-8366

January 13, 1987

DEPT. OF ARMY
OMAHA DISTRICT CORPS OF ENGINEERS
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1612 U.S. Post Office & Courthouse
Omaha, NE 68102-4978

Dear Rick:

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Rocky Mountain Ash has three Class C sources as located on the enclosed map. The basic price delivered to Denver is $28.70 per ton, although that price will vary depending on tonnage, shipment scheduling, jobsite storage, and other factors determined at the time of bid. If the haul is handled in dump trucks rather than pneumatic bulk tankers, some economy may also ensue.

Please call if you have any questions and let me know if you are in Denver in the future.

Sincerely,

Gary A. Shepherd

Gary A. Shepherd
Technical Sales Representative

GAS/cw
Encl.

Expeditionary Shelters

OVER the past 20 years, the Naval Civil Engineering Laboratory (NCEL) has investigated and developed shelter technology for the Navy and Marine Corps. Both services must be able to commit military forces rapidly and conduct operations anywhere in the world; expeditionary shelters, many with unique features, are needed to support these operations. Logistics and operational considerations require that such shelters be usable worldwide, rapidly erectable in all climates by untrained people using simple hand tools, lightweight and relocatable, and multifunctional.

Expeditionary shelters must fit in standard 8-by-8-by-20-foot International Organization for Standardization (ISO) containers for shipping. Airlift considerations have reduced the shipping volume for some shelter applications to compatibility with 463L airlift pallets (104 by 88 by 96 inches). Ground transportation assets limit shipping weight to 5 tons gross.

The Marine Corps Expeditionary Shelter System was developed in the 1970's. It consisted of a family of hardwall knockdown shelters that were shippable in standard ISO containers. These shelters ranged in size from a small 8-by-8-by-20-foot structure to a hangar that was 60 feet wide, 25 feet high, and 28 feet long. While the ISO compatibility requirement reduced the logistics burden somewhat, the shelters were incompatible with evolving Marine Corps mobility requirements and were not cost effective. In 1982, emphasis was placed on developing lighter weight, more rapidly erectable, and less expensive structures.

NCEL Shelter Program

The Navy and Marine Corps expeditionary shelter program at NCEL has evolved in three major areas: the CH-53E helicopter and P-3C aircraft hangar, medium-sized field structures, and tents. The development of an expeditionary hangar involved investigating the use of existing commercial prefabricated metal, fiberglass, and tension structure technology. Weight, shipping volume, erection, relocation, and economic considerations eliminated metal and fiberglass structures.

Commercial frame-supported tension structure technology was used in constructing two hangars (Figure 1). One was a parallel arch design and the other used a diagonal arch. The diagonal arch hangar was erected with hand tools and required no work higher than 10 feet above the ground. Both concepts greatly reduced weight, shipping volume, and costs. However, their erection was labor intensive and the parallel arch design required a crane and offground work for assembly.

While many of these characteristics are acceptable for expeditionary use, and frame-supported tension structure technology is promising, existing commercial technology does not meet all the requirements for an expeditionary structure. Efforts are underway to develop lighter structural members, simplify and reduce frame assemblies, and decrease erection time.

Medium-sized structures vary in size from 20 by 40 feet to 60 by 120 feet. They are needed for logistics, maintenance, command, housing, and other uses. Commercial frame-supported tension structures (Figures 2 and 3 are a few examples) need major modifications to meet all expeditionary requirements. NCEL is developing a family of shelters that can be expanded in length, width, and height using interchangeable components. Thus, only additional frame components and fabric panels are needed to enlarge a building from 20 by 40 to 60 by 120 feet or to several sizes in between.

The structures can withstand steady wind speeds up to 120 mph and a snow load of 20 lbs./ft.^{2}. No component exceeds 100 pounds and 463L airlift pallets can be used for shipping. Erection time for a 40-

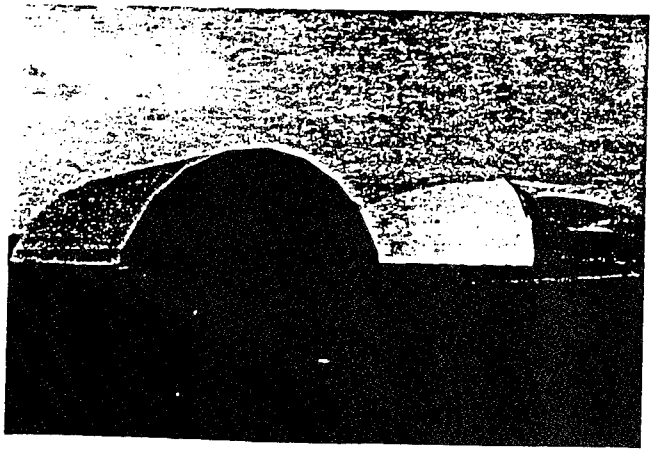


Figure 1. The parallel arch frame-supported tension structure (l) and the diagonal arch structure on the right.

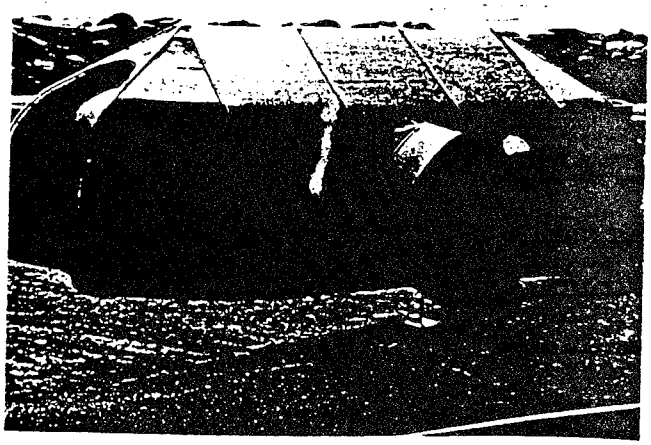


Figure 2. One example of a commercial frame-supported tension structure for medium-sized buildings.

Assista[illegible]ders

The Naval Civil Engineering Laboratory provides assistance to outside organizations through the Facilities Engineering Support Office (for Naval Shore Activities) and through the Office of Research and Technology Applications (for other federal, state, and local government organizations and private industry). The authors' telephone numbers have been included with their biographical sketches to assist you in making specific inquiries about the research described. To obtain assistance in solving other facilities engineering related problems, simply outline your inquiry and forward it to:

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The Laboratory will evaluate your inquiry and determine what technology or capabilities are available to assist you. Naval Shore Activities may telephone inquiries directly to the Facilities Engineering Support Office—Autovon 360-4070 (24-hour answering service).

Availability of Technical Documents

Many of the Technical Documents referenced in this issue were prepared by the Naval Civil Engineering Laboratory and have been approved for public release. The Laboratory has produced over 700 Technical Reports, 1,600 Technical Notes, and 2,000 Techdata Sheets as part of its Technology Transfer effort. If you would like to receive any of these documents, please enter below the Title and Document Number and mail your request to: Naval Civil Engineering Laboratory (LO08), Port Hueneme, CA 93043. A photocopy of the order form may also be used. The document will be forwarded if available and releasable.

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By Joseph L. Ashley and LTJG Donald H. Gatchalian



Joseph L. Ashley *is the Shelter Project Leader at NCEL and is assigned to the Combat Support Systems Division. At NCEL, he has managed projects for the Energy, Amphibious and Advanced Base, and Marine Corps research programs. He holds a B.S. degree in physics from Northeast Louisiana State University, an M.S. degree in engineering from Old Dominion University, and is a registered professional engineer in Wisconsin. He served four years in the Navy as a commissioned line officer.*



LTJG Donald H. Gatchalian *is the Assistant Program Manager for the Amphibious and Advanced Base Department at NCEL. He joined the Navy as a Seaman Recruit and attained the rank of Engineering Aid First Class Petty Officer before being commissioned an Ensign in the Civil Engineer Corps. Lieutenant Gatchalian holds a B.S. degree (with honors) in civil engineering from the Far Eastern University in Manila. He is a registered professional engineer in California and in the Philippines.*

by-60-foot building is 32 labor hours. Development of the Marine Corps Family of Tension Structures, Medium Sized, will be completed and approved for procurement by 1991.

Shelter Evaluation

Two tents evaluated as possible replacements for existing Marine Corps tentage were the U.S. Army Tent, Extendable, Modular, Personnel (TEMPER) developed by the Natick Research and Development Center (Figure 4) and the Expando Tent by the Brunswick Defense Corporation (Figure 5). Both tents had many characteristics superior to existing tentage; however, neither met the Marine Corps' expeditionary requirements.

Several technologies, including tension structures, are being investigated to develop a tent that is simple to erect, lightweight, modular and expandable, and compact. Development of the Marine Corps tents will be completed and approved for production by 1990.

Summary

NCEL has become a center of expertise for expeditionary shelters. We have shown that frame-supported tension structure technology appears to solve many of the military's shelter problems. The development and introduction of this technology will greatly reduce the logistics, erection, and economic burdens now associated with shelters used to support military operations.

Commercially available shelters and commercially developed technology, without major modifications, will not meet the requirements for Navy and Marine Corps expeditionary shelters. Simplicity in construction and erection cannot be overemphasized.



Figure 4. NCEL evaluated the Army TEMPER tent for Marine Corps requirements. This was developed originally by the Natick R&D Center.

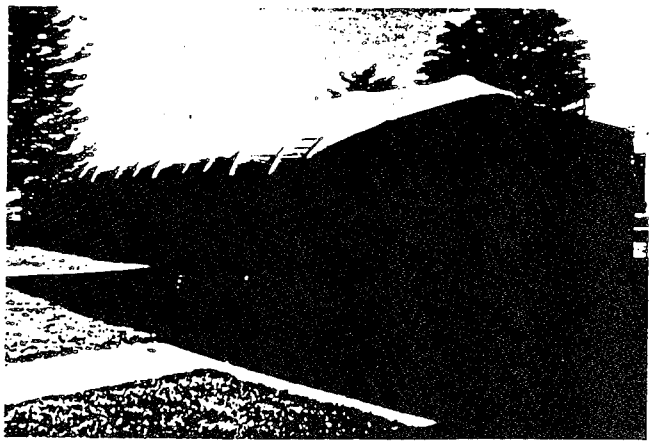


Figure 3. Another commercial example structure. All these need modifications for expeditionary requirements.

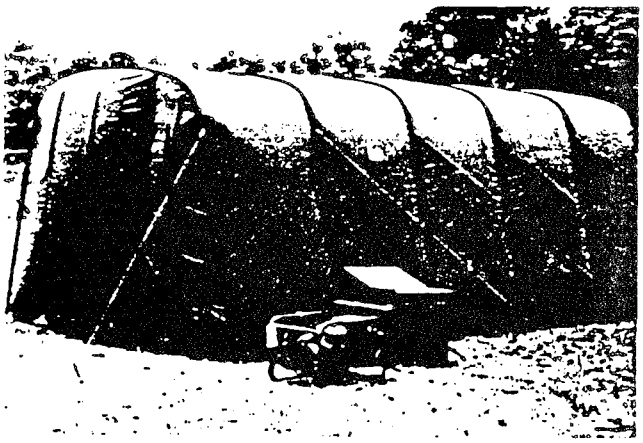


Figure 5. Another tent with many characteristics superior to existing tentage was Brunswick's Expando Tent.

Properly designed exhaust systems use a variety of hoods to capture process contaminants close to the point of generation, preferably with a high-velocity, low-volume approach. Cyclones or fabric filter collectors gather the captured dust before disposal.

Design Guidelines for Dust Control Exhaust Systems

Hoods, capture velocities, and air pollution control equipment

JOHN A. CONSTANCE, PE, The Engineers Collaborative Inc., Newtown, PA

There are many technical publications available explaining how to engineer and design an industrial dust control exhaust system. This information covers operational procedures and design parameters for hoods, ducts, exhaust fans, and dust collectors. Adapting these procedures to plant problems results in an effective exhaust system that reduces the concentration of nuisance or hazardous dusts and improves worker health and safety, product quality, and process effectiveness.

However, applying this information to a process's particular dust control problem is a serious challenge to designers who do not deal with dust control layouts regularly. This two-part series provides guidelines and recommendations for dust control exhaust system design. (The first article, PE 7/10/86, p 48, file 2530, discussed general exhaust system considerations, dust characteristics, production factors, and air recirculation.)

Hoods — Dust capture hoods should be adapted to the operations they are serving and should not interfere with the process or product. The closer the hood is to the dust source, the less air needed to capture the contaminant. The hood should be shaped to get close to the dust source, and it should be sized to assure smooth airflow and proper control velocity.

Hood design should fit the dust problem. Canopy hoods are effective over thermally driven contaminants but are not as practical as lateral hoods in capturing contaminants thrown horizontally. Canopy hoods tend to draw contaminants past the workers' breathing zone, and lateral hoods pull contaminants to the side, away from the employees.

Access to the interior of dust capture hoods should be provided for cleaning. Aluminum hood construction is often needed to eliminate the chance of striking a spark when working in an explosive process.

The design of the dust capture hood is probably the least understood and, as a result, the weakest link in dust control exhaust systems. It is possible to improve the efficiency of existing systems substantially by adding properly designed dust capture hoods. In many cases, this benefit is realized without replacing any major components. Although the final result is not as effective as a new system with all components coming from a finely tuned design, noticeable improvements are achieved at a relatively low cost and with minimum production downtime.

Capture Velocities — Dust capture velocities are developed after hood configurations and locations are selected. Published data on the selection of capture velocities are based on the velocity of dust particles released, as well as the speed of the ambient air.

Proper velocity is more critical if the process product involved is valuable. Too high a capture velocity provides good dust control but carries away a portion of the valuable raw material.

High-velocity, low-volume dust control systems are often the best choice. These systems require only a few hundred cubic feet of air per minute, ductwork is compact because of the small air quantities needed, air pollution control equipment is reduced in size, and makeup air requirements are minimal.

Air is exhausted at a high velocity (up to 20,000 fpm) very close to the point of dust generation. The air overcomes the velocity of the dust generated and carries it away. The high-velocity, low-volume concept should be applied to dust control problems whenever possible. This approach is especially well suited to applications with a reachable point source of dust generation, such as disk sanders, pneumatic chisels, and hand grinders.

Unfortunately, it is not always possible to get close to the dust source because of production considerations, or the source of dust generation may be a larger area, perhaps 2 or 3 sq ft. Higher exhaust air volumes are needed to capture dust effectively over this much space.

Air Pollution Control Equipment — Pollution control equipment is available in a number of designs using var-

...is operating principles. Equipment characteristics differ in collection efficiency, and construction, maintenance, and operating costs. Cyclones and fabric dust collectors are usually preferred over the wet methods because disposal of collected material is easier and less energy is consumed.

Cyclones are applied to service a wide range of chemical and physical conditions. Initial and maintenance costs are generally lower than those of other types of equipment; however, collection efficiencies also are typically lower. Dusts up to about 10 microns are not collected effectively.

Fibrous dust, such as that found in paper converting operations, is very difficult to capture in fabric collectors. Fibers fill the spaces inside or around the filter tubes; therefore, fibrous particles are not released easily into the dust collector hopper, and the unit plugs solid. Standard dust collectors are extensively modified to alleviate the problem, at a premium price.

In addition, special design cyclones collect fibrous dust at efficiencies over 99 percent. Emptying problems are eliminated by proper design of the internal arrangement of the cyclone.

Fabric collectors are usually used when high collection efficiency is desired on small particles. The concept of capturing particles on the surface of tubular fabric filter media has been around since the early 1900s. Recently, new developments in the shape of the filter media were realized by using a pleated cartridge to collect particles.

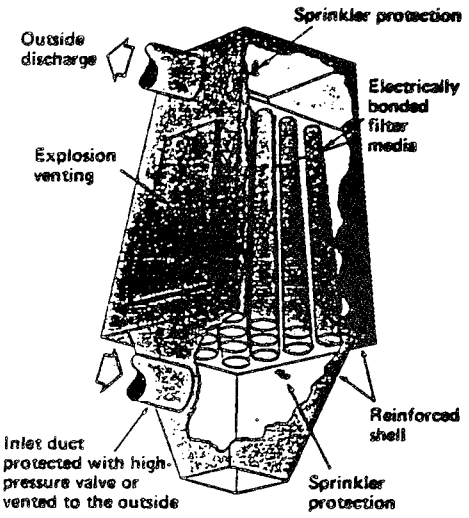
The pleated cartridge filter, however, is not applicable for collecting all types of dusts. It is more sensitive to fibrous particles, such as long-fiber sawdust. Also, care should be taken when handling hygroscopic materials in plant environments where the air is not humidity controlled. If there is any doubt, test collectors should be tried before capital is invested. It is also advisable to visit existing plants applying cartridge collectors for a similar dust problem to obtain performance and maintenance information.

One of the more significant advantages of the pleated cartridge dust collector is in maintenance. Cartridges of some models are removed from the outside of the collector housing. Access is gained through portholes on the side of the unit. Maintenance personnel slide cartridges directly into plastic bags as they are removed from the housing. Employees are exposed only to ambient plant air and are isolated from possible concentrated toxic dust conditions.

If the collected dust is flammable or explosive, precautions should be taken to protect personnel and equipment from fires and explosions. Energy from a spar... could initiate an explosion inside the collector. Without venting or suppression, the dust collector ruptures.

A rupture releases flames into the area surrounding the collector. If the area is dusty, a secondary explosion, stronger and more destructive than the first, could occur. The explosion inside the dust collector could send burning material back through the exhaust ducts and into the production area.

Several basic precautions should be taken to minimize the damage caused by a dust explosion inside the collector (see drawing).



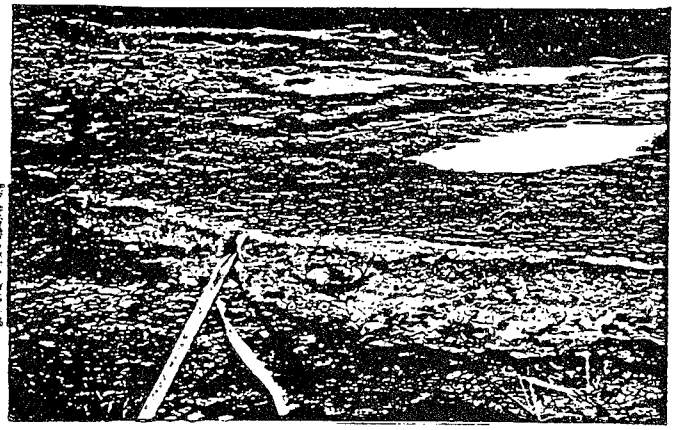
Dust collectors should be specially-equipped if the contaminant is flammable or explosive. Protective equipment includes proper venting, reinforced shell, electrically bonded filter media, sprinklers, and fire and smoke dampers.

- The dust collector should be located outside the plant, if possible, or inside near an outer wall away from personnel to permit proper explosion venting to the outside.
- Explosion venting should be sized according to the volume of the dust collector, maximum pressure rise of the ignited dust, and maximum rate of pressure rise of ignited dust.
- The dust collector shell should be strong enough to withstand the initial pressure rise before the vents release the pressure.
- Inlet ductwork to the dust collector should be vented to the outside.
- Dust collector filter tubes should be the static dissipative type to minimize the chance of ignition because of static discharge caused by dust released from the filter tubes.
- Sprinklers should be installed in the dust collector to extinguish fires; flow switches in the sprinklers should be interlocked with the exhaust system fan and drive to stop airflow.
- Fire and smoke dampers should be installed in the ductwork to protect the production area.

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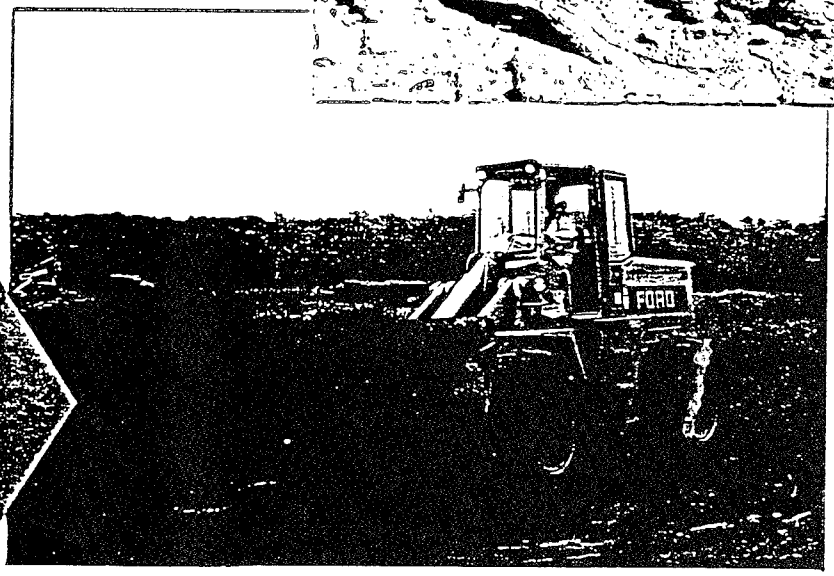
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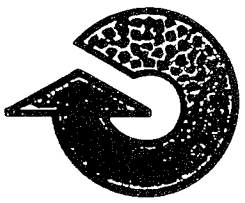
Envirite Field Services' HSS stabilization system is applicable to contaminated soils and to sludges with moderate to high solids contents. This approach involves processing of inorganic or organic industrial and municipal wastes either within a section of an existing impoundment or on a nearby processing area. Processing steps include excavation, layering, conditioning, and solidification/fixation. Selection of the conditioning and solidification/fixation additives is made based on our laboratory evaluation in order to achieve the desired levels of structural stability, impermeability and leach resistance. The HSS technology minimizes the volume increases which typically result from the use of bulk stabilization agents. The process is particularly applicable to on-site disposal of contaminated soils and high solids content sludges.

A treatment area of suitable size is selected and prepared, depending on project requirements, either within the impoundment or nearby. Sludge or contaminated soil is then carefully spread in a uniform layer throughout the treatment area. Conditioning and solidification/fixation additives are mixed with the layered waste and homogenized by mechanical equipment. The treated waste is either stockpiled for transportation to an on-site placement area or is compacted in place to serve as a working platform for the next layer of waste. The final layer is covered in accordance with an approved closure plan for the site.

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600 WEST GERMANTOWN PIKE PLYMOUTH MEETING EXECUTIVE CAMPUS
PLYMOUTH MEETING, PA 19462 (215)825-8877

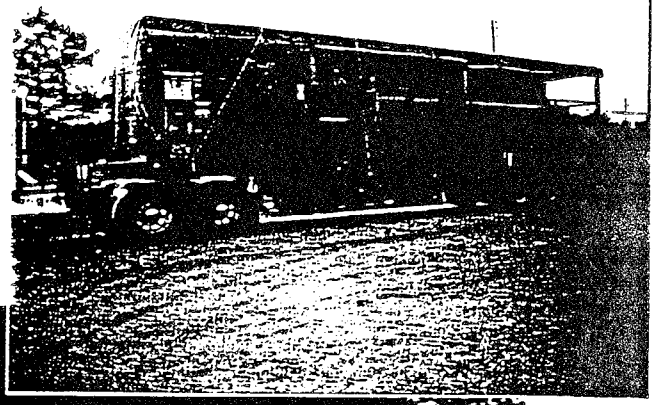
Shipping Address: 850 W. Valley Forge Rd.
King of Prussia, PA 19406

VR/S™ VOLUME REDUCT STEM

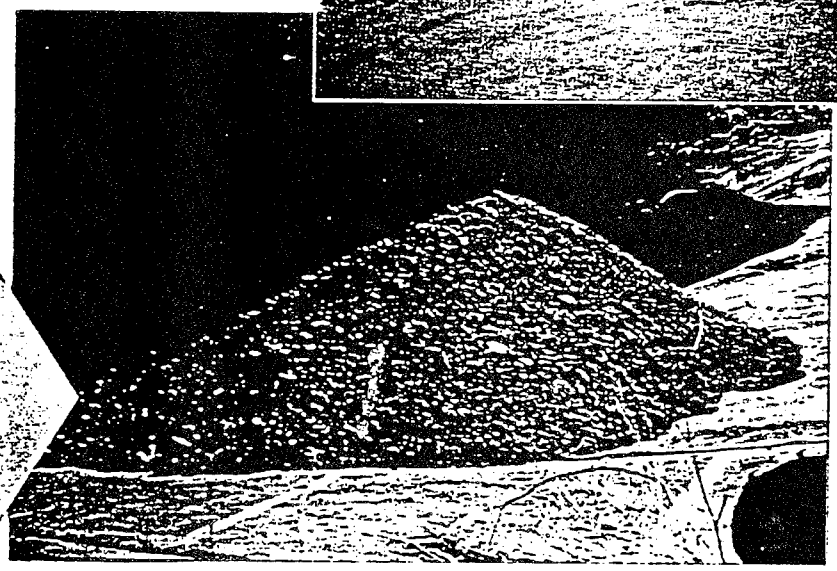
WASTE POND BEFORE TREATMENT



VR/S DEWATERS AND STABILIZES



TO FORM LOW PERMEABILITY, LEACH RESISTANT AND STRUCTURALLY SOUND PRODUCT READY FOR LANDFILLING



VR/S™ VOLUME REDUCTION/STABILIZATION SYSTEM

Envirite Field Services' VR/S stabilization technology is particularly applicable to low solids content sludges. This approach couples mechanical dewatering with solidification or fixation of inorganic or organic industrial and municipal sludges. The new process reduces the volume of material to be disposed of by dewatering and provides the added benefit of solidification/fixation without the volume increases which typically result from the use of bulk stabilization agents. The solidified/fixed product is tailored to meet the client's specific requirements for leachate control, permeability, and structural stability. Various dewatering means, such as pressure or vacuum filters, can be utilized. The proprietary system has achieved overall volume reductions of up to 80%. The process is particularly applicable to on-site disposal where volume constraints exist and to off-site disposal where transportation and landfill fees are a consideration.

Sludge is pumped from the impoundment or containment area to the dewatering/stabilization unit, where it is then conditioned, dewatered, and stabilized. Portable and fixed treatment facilities are available, depending on project size. The treated material is suitable for immediate placement in an on-site or off-site landfill. The process differs from simple dewatering in that superior permeability, leaching, and structural properties are achieved in the treated sludge. Tests conducted show that while untreated dewatered samples disintegrate under controlled soak tests within 28 days, VR/S treated materials maintain their structural integrity.

THE PERMIX™ PROCESS treated sludge yields the following characteristics:
• STRUCTURAL INTEGRITY • LOW PERMEABILITY • LOW LEACHABILITY

THE PERMIX PROCESS = LOWER COSTS

The total costs of waste treatment are site specific and vary due to mobilization, reagent, labor and travel costs. Quoted costs have ranged from $0.06 to $0.30 per gallon and are generally 20 to 40 percent less expensive than off-site disposal where transportation and landfill fees are a consideration.

ENVIRITE
FIELD SERVICES
TECHNOLOGY FOR THE ENVIRONMENT

600 WEST GERMANTOWN PIKE PLYMOUTH MEETING EXECUTIVE CAMPUS
PLYMOUTH MEETING, PA 19462 (215)825-8877

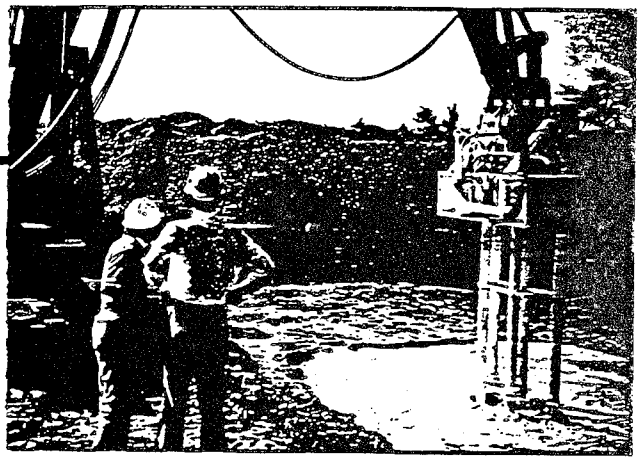
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King of Prussia, PA 19406

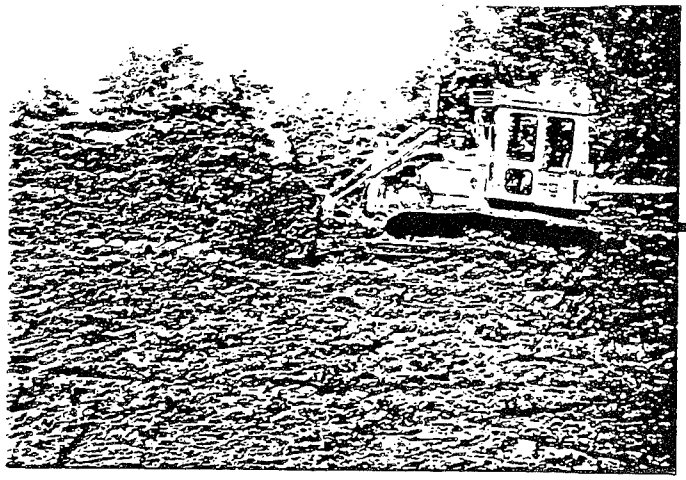
PERMIX™ PROCESS

STABILIZATION SYSTEMS

The Permix solidification/fixation technology can provide a solution to your specific waste management problems.

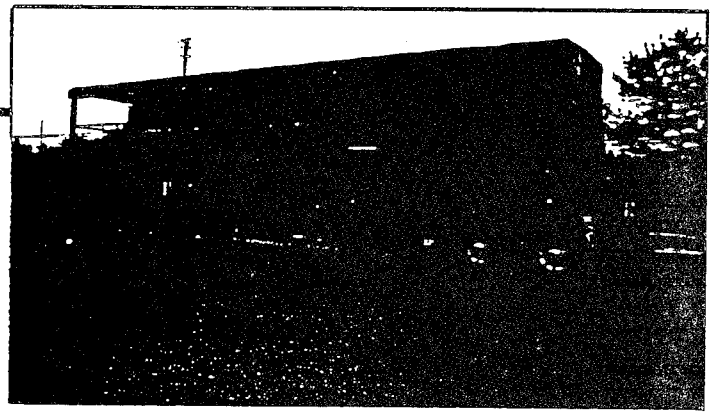
In situ injecting and mixing of solidification/fixation additives to provide a stable landfill material.





HIGH SOLIDS STABILIZATION:

Landfilling approach to manage accumulated high solid sludges and contaminated soils.



Dewatering combined with solidification/fixation to provide a volume reduced, stable landfill material.

ENVIRITE
FIELD SERVICES

TECHNOLOGY FOR THE ENVIRONMENT

PF-5™ STABILIZATION

The PF-5™ system injects and mixes selected additives with waste liquids or sludges in a pond or a lagoon.

The homogenized sludge/additive mixture solidifies into a low permeability, leach resistant, structural material which can be left in the impoundment, removed to a landfill, or used in structural applications.

HIGH SOLIDS STABILIZATION

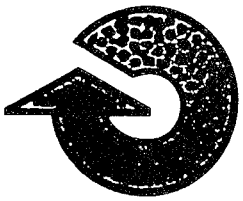
The HSS™ system provides an economical method for fixation or solidification of high solids content impounded waste sludges and contaminated soils.

The waste is placed in a segregated process area in layers. It is then combined with a customized formulation of solidification/fixation additives. The mixture is homogenized by mechanical equipment and is then stockpiled for removal or compacted in place by using earth moving equipment.

VOLUME REDUCTION/STABILIZATION

The VR/S™ system uses mechanical dewatering equipment in combination with solidification or fixation technology to treat low solids content impounded waste sludges.

The treated waste is a low permeability, leach resistant, structural material which is suitable for immediate placement in an on-site or off-site landfill.



ENVIRITE
FIELD SERVICES

TECHNOLOGY FOR THE ENVIRONMENT

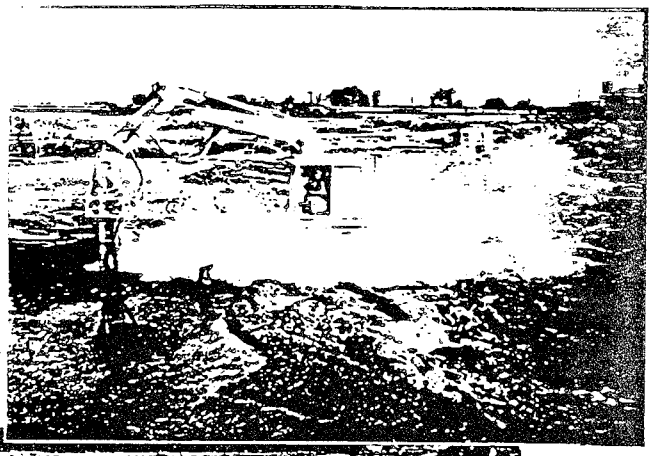
600 WEST GERMANTOWN PIKE PLYMOUTH MEETING EXECUTIVE CAMPUS
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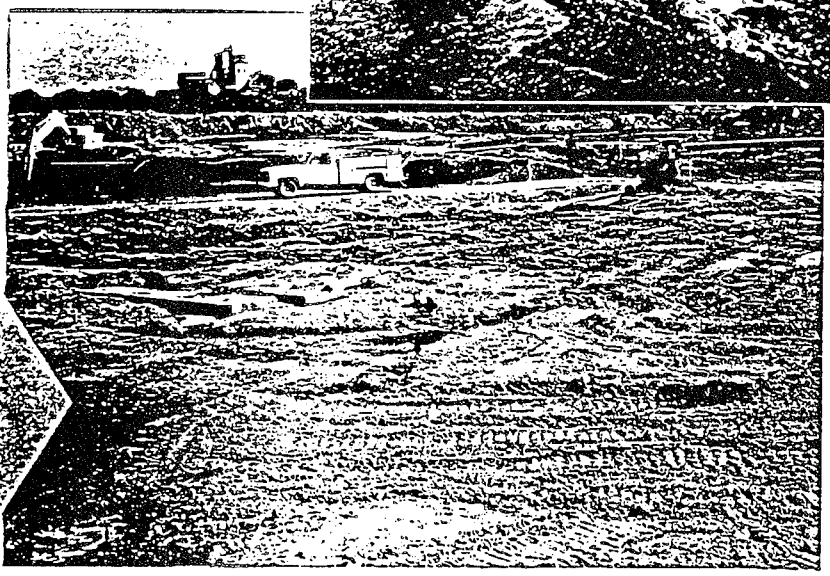
PF-5™ STABILIZATION S



WASTE POND
BEFORE TREATMENT



PF-5 COMBINES SELECTED ADDITIVES



TO FORM LOW
PERMEABILITY
LEACH RESISTANT AND
STRUCTURALLY SOUND
PRODUCT READY FOR
CAPPING

PF-5™ STABILIZATION SYSTEM

Envirite Field Services' PF-5 pond injector provides a system for injecting and mixing selected additives with waste liquid or sludge in an existing impoundment. Formulations for specific inorganic or organic wastes are customized in our laboratories in order to achieve the desired levels of structural stability, impermeability and leach resistance. The PF-5 has five injection tubes, each with a separately controlled feed system and sludge/additive dispersion mixer. The tubes allow injection of additives directly into the ponded wastes, up to a depth of eleven feet. A customized version can attain greater depths. When operating, the PF-5 is mounted on a mobile unit which reaches into the pond from the perimeter. Power for the PF-5 is obtained from its own independent portable source.

The PF-5 homogenizes ponds of varying compositions prior to addition of solidification/fixation additives. Homogenization assures a consistent mixture of wastes throughout the pond and thus yields a consistent mixture of treated waste. After homogenization, the proper proportion of additives is injected and intimately mixed in place. Once the pond perimeter is solidified, the mobile equipment is moved directly over the solidified perimeter to reach the remaining untreated areas. The unit continues to work from the solidified areas until the entire pond is treated. The resulting stabilized monolithic mass is covered in accordance with an approved closure plan for the site.

THE PERMIX™ PROCESS treated sludge yields the following characteristics:
• STRUCTURAL INTEGRITY • LOW PERMEABILITY • LOW LEACHABILITY

THE PERMIX PROCESS = LOWER COSTS

The total costs of waste treatment are site specific and vary due to mobilization, reagent, labor and travel costs. Quoted costs have ranged from $0.06 to $0.30 per gallon and are generally 20 to 40 percent less expensive than off-site disposal where transportation and landfill fees are a consideration.

ENVIRITE
FIELD SERVICES
TECHNOLOGY FOR THE ENVIRONMENT

600 WEST GERMANTOWN PIKE PLYMOUTH MEETING EXECUTIVE CAMPUS
PLYMOUTH MEETING, PA 19462 (215)825-8877

Shipping Address: 850 W. Valley Forge Rd.
King of Prussia, PA 19406

Lefco Western, Inc.™
SERVICE WITH SAFETY!

Phone: ac 713/941-8442

4901 Cripple Creek, Glenbrook Park • Houston, TX 770 7

January 21, 1987

H.D.R.
8404 Indian Hills Drive
Omaha
Nebraska 68114

Attention: Mr. Craig Osbourne

Dear Mr. Osbourne:

Further to our conversation with regards to your project near Denver, I have pleasure in submitting the following as a guide to the potential cost of performing the work as I describe in my methodology.

Scope of Work:

Project site is approximately 92 acres. The site contains approximately 429,000 cu. yds. of contaminated sludges and soils. The material needs to be stabilised and stockpiled on site for future disposal. The stabilising mix to be approximately 1% to 8% flyash, and additional dirt or soil to bring material so as to pass paint filter tests.

Method of Work:

Using heavy dirt equipment, 16 ft. wide roads will be pushed through the contaminated material 60ft. apart for the whole length of the site. The roads will be made out of a blend of flyash and soil. Using draglines and dump trucks on these roads we will remove all materials to a blending pad where the flyash and soil will be added to achieve the correct texture. The blended materials will be pushed up and stockpiled close to the blending area. The blending pad will contain a receptacle hopper for contaminated material; from here the material will be fed into twin screw conveyors where the blending materials will be added. The finished material will be transferred to the stockpile using a conveyor system.

lefco Western, Inc.™
SERVICE WITH SAFETY!

Phone: ac 713/941-8442

4901 Cripple Creek, Glenbrook Park • Houston, TX 77017

Our estimate for supplying the management and equipment to perform the project will be approximately $6.75 per cu. yd. Obviously these are only preliminary figures based on work of this type we have previously undertaken.

As a possible suggestion to the final disposal of the blended material, we have been associated with some microbial treatments on sludges and soils and should you require names or additional information, we would be happy to supply it.

We appreciate the opportunity of working with you and should you require any further assistance, please do not hesitate to call us.

Sincerely,
LEFCO WESTERN, INC.

Calvin LeFevre
Vice President

CL/mlh

Another Fine Product From:

MEETING THE GROWING DEMAND FOR CLEAN WATER

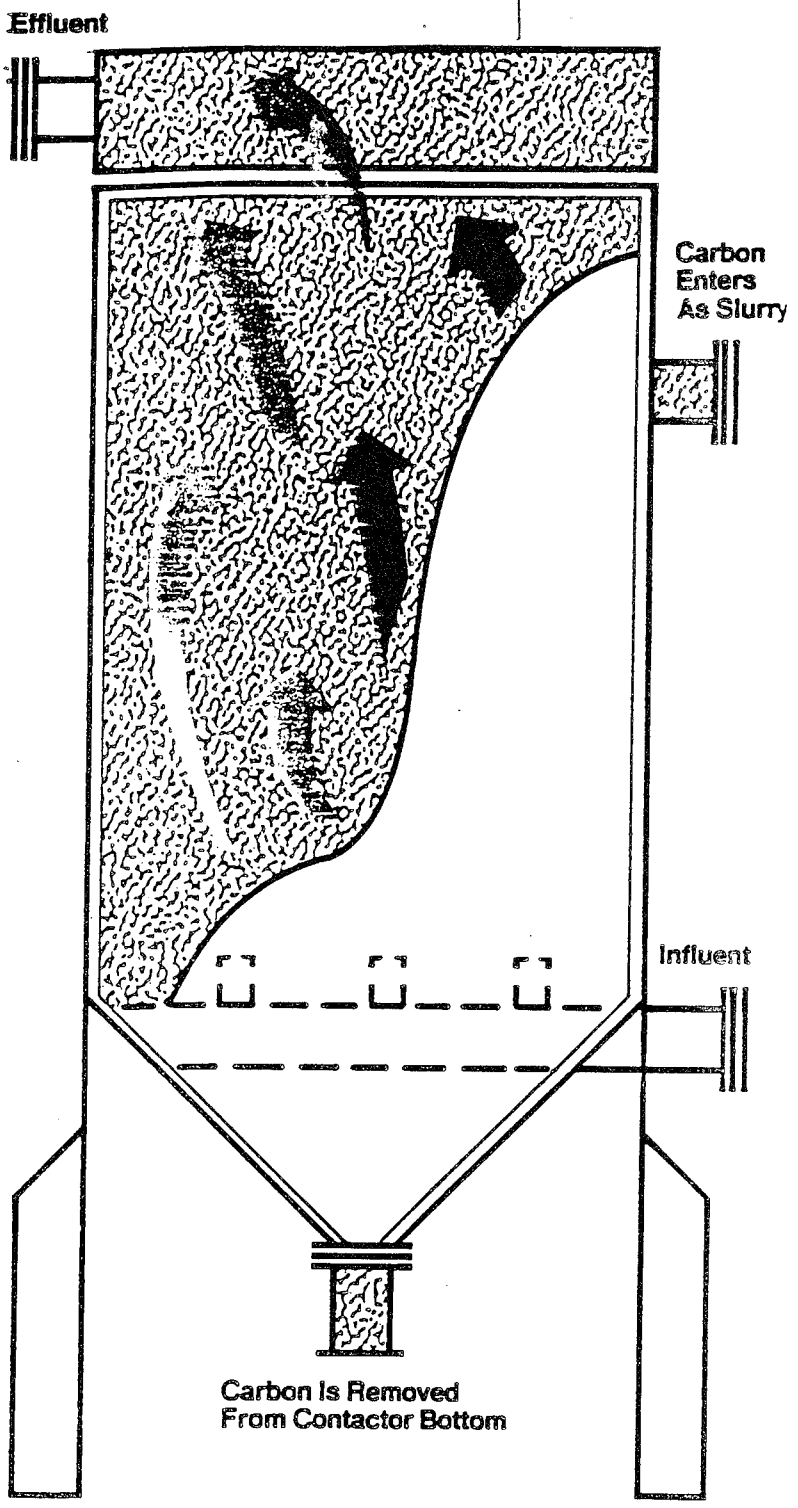
ACTIVATED CARBON CONTACTOR

Water is our most precious resource. At Davis Water & Waste Industries, Inc., we're taking giant strides in protecting this valuable commodity. Our Activated Carbon Contactor has been designed both to protect water supplies from organic chemical pollutants and, when used with appropriate pretreatment processes, to provide clean, safe drinking water.

Typical applications are for the treatment of contaminated groundwater prior to its distribution for public water supplies, the remedial clean up of hazardous waste sites and landfill leachate, and the removal of organic pollutants from industrial wastewater. Once installed, this system can meet or exceed EPA regulations for acceptable levels of organic chemicals in treated water.

The Activated Carbon Contactor can also be used for the tertiary treatment of municipal wastewater, dechlorination of water, the purification of water for food processing and in the preparation of ultrapure water for use in electronics manufacturing.

We build both gravity and pressure carbon filters, including a specially adapted version of our Traveling Bridge Filter. But we urge our customers to examine the economical benefits found in using a Davco upflow contactor, either pressurized or unpressurized, versus any competing pressure or gravity filters.



Activated Carbon Contactor Features Counter-Current Flow For Increased Economy.

BERT GURNEY & ASSOCIATES, INC.

6503 CENTER STREET
PHONE 402-551-7995
OMAHA, NEBRASKA 68106

Advantages of the Davco Upflow Contactor

In competitive filters, influent enters the top of the column and flows by pressure or gravity downward. Contaminants are, therefore, removed in the upper layers of the unit. As these layers become saturated, the contaminants penetrate downward further into the carbon bed until they break through the filter and are found in the filter effluent. This breakthrough can and does occur long before the full adsorption capacity of the activated carbon has been reached. At this point, all the carbon is removed for reactivation or disposal and the remaining adsorption capacity is wasted.

Our carbon contactors, however, eliminate this carbon waste by operating counter-current to the direction of the water flow. Influent is forced up the column, and spent carbon is withdrawn from the bottom of the column. Therefore, the most concentrated solution always contacts the most saturated carbon. Spent carbon is replaced by fresh carbon at the top of the column, and it is this fresh carbon that contacts the final effluent from the unit. The result is full utilization of all carbon and optimum performance of the system.

Aside from the more efficient and effective use of carbon, our units allow several other operating advantages. Since our carbon bed is always slightly fluidized, there is no solids build-up or pressure drop increase during a filter run and, therefore, no need to backwash the filter bed. In addition, our unpressurized contactor has one more advantage. If more contact time is required by changing influent conditions or effluent requirements, the height of this contactor may be easily increased.

With our Carbon Contactors, the economies are obvious. Carbon inventory requirements are reduced. Because our unit needs no backwashing, we eliminate the need for backwash systems. The capital expense of a stand-by unit is unnecessary because of the phased carbon replacement. Also, if influent conditions or effluent limits change, it is possible to increase the contact time at minimal expense for non pressurized contactors. Lastly, these columns may be used with other Davco units to form complete systems for biological treatment, metals precipitation, clarification, filtration, and adsorption.

Other Features

Davco contactors are designed to operate with the carbon media placed directly on the underdrain system, eliminating gravel support systems. This is accomplished using a special non-clogging filter nozzle designed to retain the media in the column while permitting the free flow of liquid.

Because of the wide variety of applications for this system, various high performance coatings are also available. Units are built in diameters from 4 up to 12 feet for flows from 60 to 700 gpm. Larger flows can be handled by multiple units. Davco also supplies various specialty grades of activated carbon tailored to meet the needs of each particular application.

We also warrant these units to be free from defects in design, materials and workmanship for a period of 12 months.* As with all our manufactured products, the Activated Carbon Contactor carries our pledge of "Single Source Responsibility".** It is our commitment that says we alone are responsible for every aspect of quality control which includes not only design, construction and process function, but also start up, maintenance, parts and service.

Additional Services

We will be pleased to provide additional services to assist you in placing your filters on line. We realize that contaminants are not always easy to identify and, therefore, we will assist you in obtaining the services of an independent laboratory. Also, we have pilot columns that you may use on a rental basis for testing at your site.

For More Information

Economy, efficiency and unparalleled performance are all Davco standards. For more information on these features and the Activated Carbon Contactor or other Davco products, contact your nearest Davco representative or call Davis Water & Waste Industries, Inc.:

*Exact terms and conditions of all warranties can be obtained by writing Davis Water & Waste Industries, Inc.
**Subject to and specifically conditioned upon the terms and conditions of the written warranty.

DAVCO

DAVIS WATER & WASTE INDUSTRIES, INC.

MEETING THE GROWING DEMAND FOR CLEAN WATER

Davis Water & Waste Industries, Inc.
1828 Metcalf Avenue/Thomasville, GA. 31792
Telephone: 912-226-5733

Project | Computed

Subject | Date | Sht. | Of

Gas-Gas Separation
Ammonia Separation from ~~Haz-Waste~~ Off Gases
Unit Operation Overview

Process	Remarks
"Direct" "Indirect" "Semidirect"	petrochem type operations, complex mechanical process operation; yields anhydrous ammonia, ammonium salts of acids ⟹ not applicable
High-Pressure Absorption in Water	not applicable
Refrigerant Condensation	
Wet Scrubbing	variations of liquid-gas contacting: packed tower, atomizing spray various chemical addition used to enhance perform

References:

Gas Purification, Kohl & Riesenfeld

Air Pollution I, II, III, Sterns

Air Pollution Control Theory, Crawford

Air Pollution, Perkins

Industrial Air Pollution Engineering, Chem Engin. Mag Staff

RECORD OF VERBAL QUOTE

Project: Name: BASIN F

Location: ROCKY MTN ARSENAL

Quote #: _____ (Estimate Sht. No. _____)

Firm: Name: A.C.E.S subsidiary of EnviroSafe

Location: 900 & 8th Ave, Suite 200, King of Prussia, PA. 19406

Telephone No.: (215) 962-0800

Person Talked To: Doug Gump

Type of Quote: _____ Supplier, material only (FOB Point: _____)

_____ Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

A. Remove material to a mix pad and then to waste pile / a quick look at this alternative indicates it will be more expensive / no dollar figure computed

B. Mixing in place and remore to a waste pile / Stabilize & condition material in place with either a front end loader or disc and use trucks to haul in-out material, quote includes equipment, manpower, site prep, mobilization, demob, decon. Based on recent similar project./ $25/yd³ level C, $30/yd³ level B, est. 400 yd³/hr level C removal and stabilization rate max.

Date Quote Received: 1-22-87

Quote Received By: OSBORN

RECORD OF VERBAL QUOTE

Project: Name: BASIN F

Location: ROCKY MTN ARSENAL

Quote #: _____ (Estimate Sht. No. _____)

Firm: Name: U.S Pollution Control

Location: Oklahoma City, Ok 73106

Telephone No.: (405) 528-8321

Person Talked To: Jan Prawdzik

Type of Quote: _____ Supplier, material only (FOB Point: _____)

_____ Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

A. Remove material to mix pad and then to waste pile / $37.94/yd³ at level C and $39.81/yd³ at level B.

B. Mixing in place and remove to waste pile / $30.35/yd³ at level C and $31.85/yd³ at level B.

both quotes include mobilization, demob, manpower, equipment and triple rinse decon. They would start with bulldozer, trackhoe and perhaps use an agricultural disc and spreader if subsurface allowed. This could cut $5/yd³ off est. Removal would be done with dump trucks

Date Quote Received: 1-22-87

Quote Received By: OSBORN

RECORD OF VERBAL QUOTE

Project: Name: Basin F

Location: Denver Co. RMA

Quote #: 1 (Estimate Sht. No. 1)

Firm: Name: McLanahan Corp

Location: Hollidaysburg PA 16648

Telephone No.: (814) 695-9807

Person Talked To: David Schellberg

Type of Quote: ✓ Supplier, material only (FOB Point: _____)

_____ Subcontractor, material installed (Cost to Prime)

Scope/Description/Amount of Quote:

Pug mill installation Cost

1 Day crew of 3 including electrician

Approx $520 Ea According to Means

Date Quote Received: 1/22/87

Quote Received By: R. Grechak

HDR Internal Memorandum

To Randy Gracheck

Date 1-23-87

Chk by RWG

From Fred Maycock

Subject Basin F
Cost Estimate
4008-02-34

Estimated cost of construction

Using direct buried conduit to encase conductors
(assumes long life ≈ 20 yrs) $331,503

Using direct buried cable
(temporary to medium ≈ 5-10 yrs) $208,208

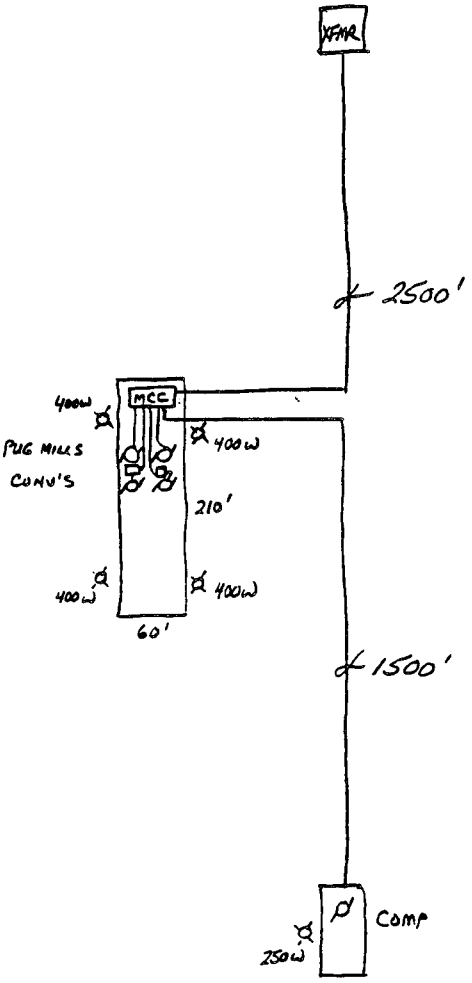
Cost to operate 20 hrs/day for 6 months $76,524

All based on the attached.

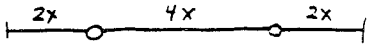
1. ONLY CONSIDER BARE ELEC COST
2. OMIT PVC CONDUIT AND ACCESSORIES
3. DIRECT BURY CABLE.

Chk by RWG

Project BASIN F	Computed FE Hayward
Subject Electrical – PM	Date 1/87 Sht. 5 Of

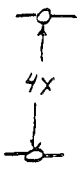


LIGHTS: GE HLX POWERFLOOD
6 x 2 BEAM SPREAD
250 + 400W 35-176381



Longitudinal
8x = 210' x = 26.25'
use 30' MH

Across
4X = 4 x 30' = 120'

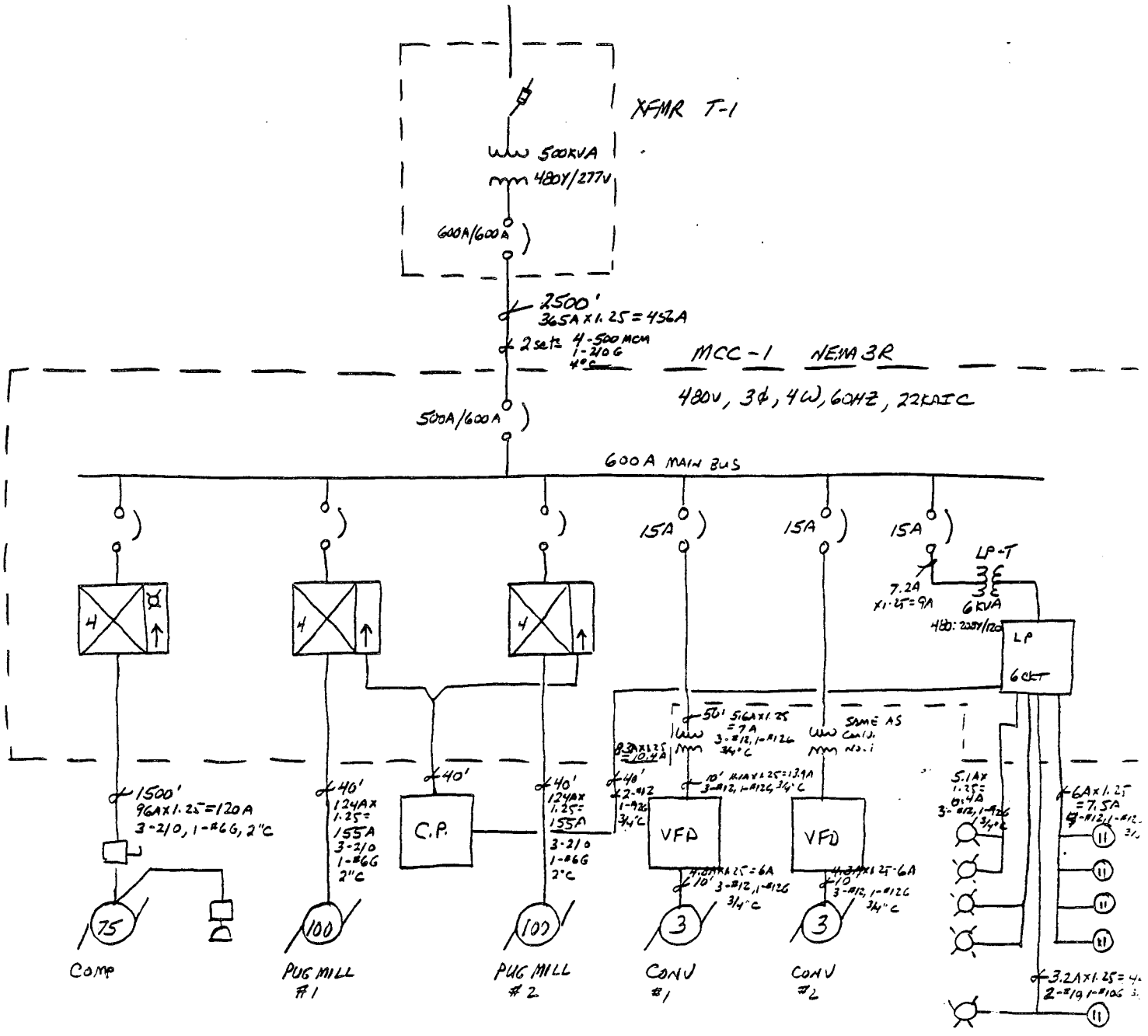


From "Quick Selector" pg 3.2 of GET-6704B
for 5 FC maintained, need 0.1 W/sq ft (using Lucalox)
Total Area = 60' x 120' = 7200 sq ft x 0.1 W/sq ft = 720 W ÷ 4 = 180 W/pole
for 10 FC need 1440 W ÷ 4 = 360 W/pole
A 400 W luminaire will yield 400/360 x 10 = 11.1 FC

Chk by RWG

Project BASIN E | Computed

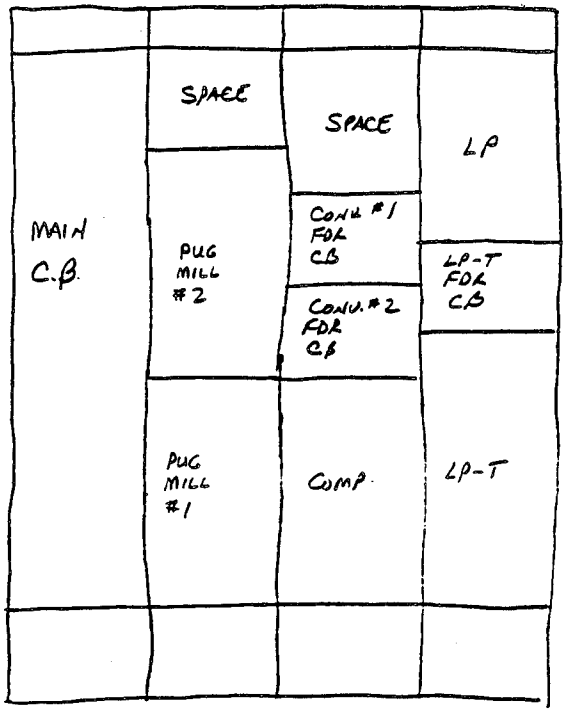
Subject Electrical - PM | Date 1187 | Sht. 6 | Of



Chk by [illegible]

Project BASIN E | Computed [signature]

Subject Electrical – PM | Date 1/87 | Sht. 7 | Of



MCC-1

Chk by RWG

Project	BASIN F	Computed	FE Hayward
Subject	Electrical - Pm	Date	1/87

Sht. 8 Of

LIGHTING LOAD: 4 @ 400W/208V ⇒ 2.2A/EA = 8.8A @ 208V ⇒ 5.1A @ 120V
1 @ 250W/208V ⇒ 1.7A/EA = 1.7A @ 208V ⇒ 0.98A @ 120V

RECEPTACLES: 5 @ 180W @ 120V ⇒ 7.5A @ 120V

CONTROL PANEL: 1000W @ 120V ⇒ 8.3A @ 120V

21.88A @ 120V ⇒ 2.6KW ÷ 0.8 ⇒ 3.25KVA

Use 6 KVA 480:208Y/120V XFMR

	480V LOAD
XFMR Load @ 480V =	7.2A
VFD Loads: 3HP Motor = 4.8A	
Allow 70% CONV. FOR VFD 4.8/0.7 = 6.9A	
VFD Loads 2 @ 6.9A =	13.8A
MOTORS	
1 @ 75HP = 1 x 96A =	96.0A
2 @ 100HP = 2 x 124A =	243.0A
TOTAL 480V LOAD	365A

POWER XFMR SIZE 365A x 0.48KV x $\sqrt{3}$ = 303 KVA

Use 300 KVA Transformer

chk by RWG

Project BASIN F | Computed FE Hayward

Subject Electrical - PM | Date 1/87 | Sht. 9 | Of FL

UTILITY COST 20 HRS/DAY 6 MONTHS

MOTOR LOAD $281\ HP \times \frac{0.746\ KW}{1\ HP} = 210\ KW$

FOR 20 HRS = 20 HRS x 210 KW = 4200 KW HR's / DAY

6 MO's ≈ 182 DAYS

4200 KW HR / DAY x 182 DAYS = 806,400 KW HRS

USAGE CHARGE @ $0.06 / KW HR = $48,384

DEMAND CHARGE @ $10.00/KW

6.3 KVA/HP x 100 HP x 0.746 KW/HP = 470 KW

470 KW x $10.00/KW = $4700 / month

TOTAL USAGE + DEMAND CHARGE FOR 6 MONTHS $48,384 + $4700 x 6 = $76,584

Add in 30 HP for Feed Pumps (Chemical)

Other Pumps

∴ 281 + 30 = 311 HP = 232 KW

$$\frac{232\ KW \times 24\ hrs \times 130\ days}{day} = 720,000\ KW\ HR$$

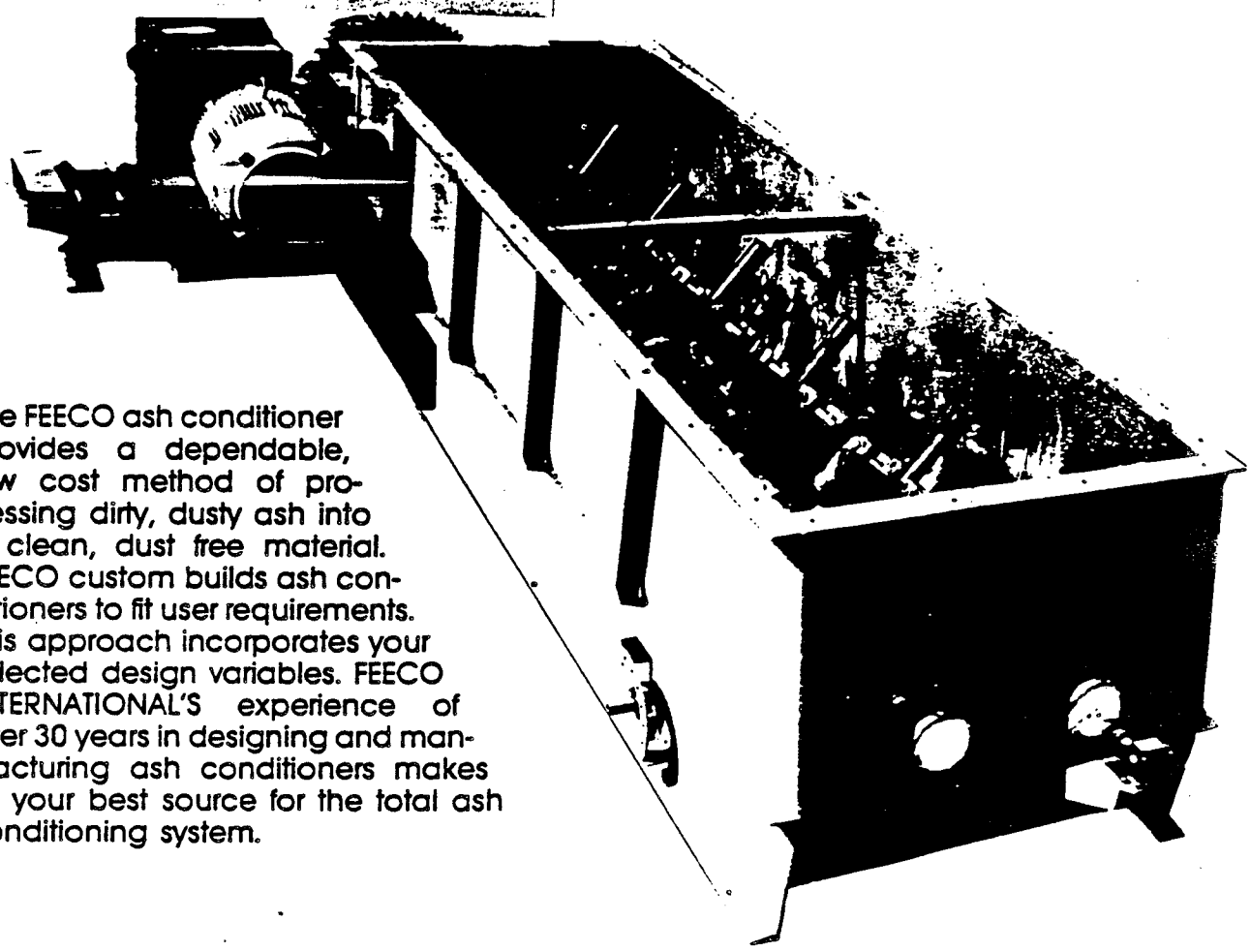
Feeco International

Feeco
INTERNATIONAL, INC.

ASH CONDITIONING SYSTEMS

Quality designed and constructed to save time and money over many years of operation.

THE F[illegible]SH CONDITIONER



The FEECO ash conditioner provides a dependable, low cost method of processing dirty, dusty ash into a clean, dust free material. FEECO custom builds ash conditioners to fit user requirements. This approach incorporates your selected design variables. FEECO INTERNATIONAL'S experience of over 30 years in designing and manufacturing ash conditioners makes us your best source for the total ash conditioning system.

THE FEECO ASH CONDITIONER AT WORK

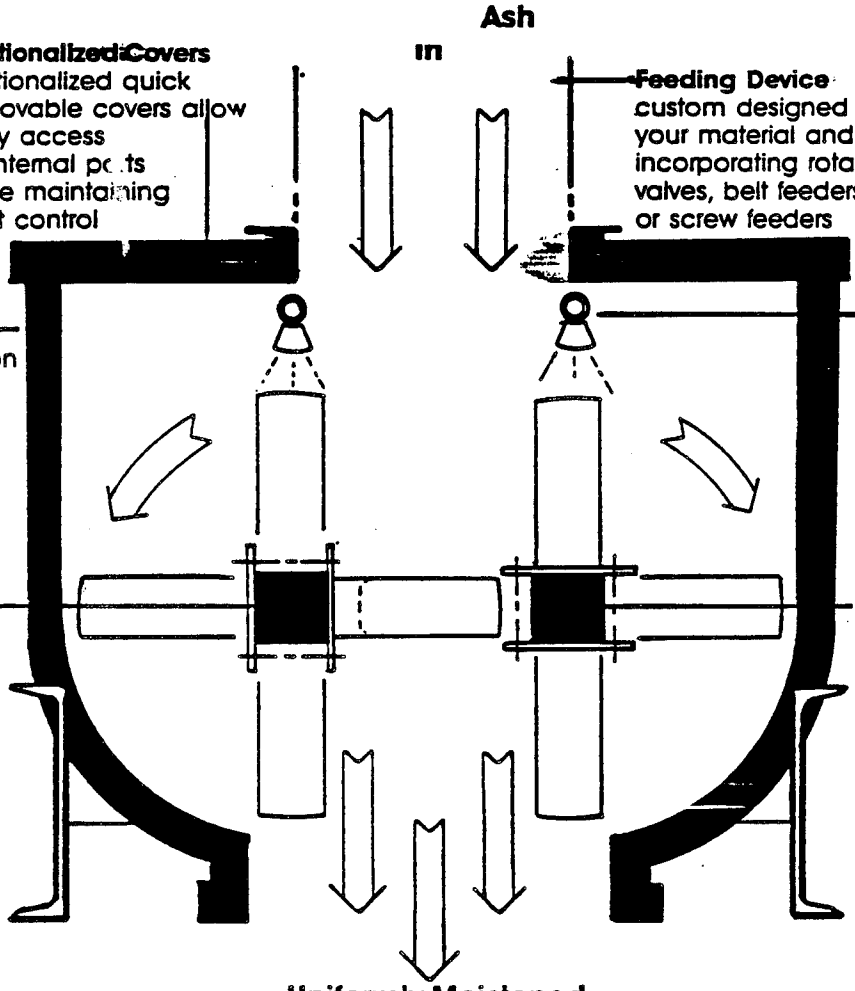
1. Ash enters the unit through a feeding device.

2. Water is sprayed into the unit through a series of specially designed hollow cone nozzles which ensure fine spray and proper conditioning of the ash.

3. The material is fed through the rotating paddles and water is added at a predetermined material/water rat The action of the pitched paddles moves the materi from the bottom of the tank up each side and forces the ash back down between the shafts. This creates a folding-over effect ensuring maximum exposure of t ash to the water spray.

4. The conditioned ash moves through the mixing to from the inlet area to the outlet where the uniformly moistened material is discharged through a chute a the bottom of the tank.

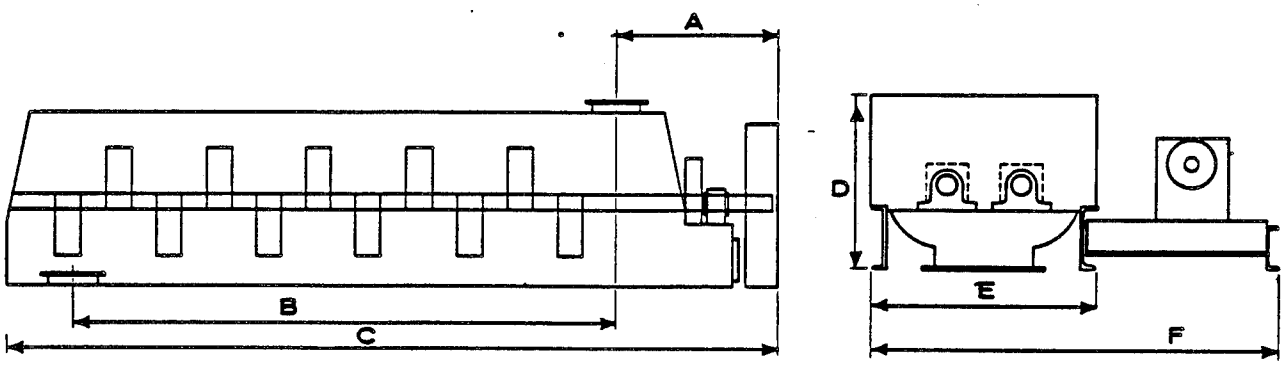
TH SYSTEM



WHY CHOOSE FEECO

- FEECO ash conditioners are built to last many years of operation. The conditioning tank is heavy body plate construction with angle reinforcing.
- Solid square paddle shafts are utilized. This gives the strongest possible grip for the paddles.
- Paddles are fabricated from abrasion resistant steel.
- Paddles are bolted to the shafts so that the position or pitch can be field modified with only a wrench.
- Paddles are also available with replaceable Ni-hard facings for extended life.
- Bearings are pillow blocks and are mounted outboard from tank avoiding leakage common with flange mounted bearings.
- Gear reducer and its internal gears have a service factor of 1.5 based on motor horsepower and not break horsepower.
- Components — reducers, couplings, motors, and bearings are manufactured by nationally known manufacturers and are readily available through local distributors or FEECO customer service.
- Couplings designed to reduce shock loading between conditioner and reducer — thus extending unit life.
- Full load start up accommodated by motor horsepower selection.
- FEECO conditioners designed for 24 hour 365 day operation.
- FEECO conditioners designed for ash — not a converted mixer.
- Unitized base for easy installation.
- Adequate material feed accommodated by engineered design.
- Special sizing available.
- Dual shaft reliability and performance.
- Sectionalized covers for access and dust control.
- Time tested and proven spray system.

ORDERIN



Sizing and Dimensions

Discharge Capacity	10 TPH	30 TPH	75 TPH	125 TPH	175 TPH	225 TPH
Dimension A	3'-2¾"	3'-9"	4'-10¼"	5'-5½"	3'-9¾"	3'-9¾"
Dimension B	10'-0¾"	10'-4⅝"	11'-8¼"	10'-8½"	11'-0¼"	11'-0¼"
Dimension C	15'-0"	15'-10"	18'-4½"	18'-6"	16'-3¾"	16'-3¾"
Dimension D	1'-11⅛"	2'-7⅛"	3'-5⅛"	4'-4⅛"	4'-9⅛"	5'-0⅛"
Dimension E	2'-3½"	3'-3"	4'-6"	5'-6"	6'-7¾"	7'-3¼"
Dimension F	5'-7"	6'-11¼"	8'-2½"	9'-8¼"	10'-9½"	11'-7½"

Motor HP: Available from 5 thru 150

Capabilities are based upon dry, fluidized fly ash weighing 40 lbs./Ft.³

OTHER FEECO SYSTEMS AND SERVICES

- Material handling for boiler conversions and FGD sludge.
- Granulation systems
  - Pans
  - Pugs
  - Drums
- Drying systems (rotary)
- Cooling systems
- River terminals

FEECO INTERNATIONAL operates an Applications Research Laboratory in which conditioners are used to test your material to determine variables such as percent liquid to be added, solid feed rate, retention time, paddle speed, paddle size, and configuration.

For an early exchange of ideas on how you can profit by using FEECO INTERNATIONAL on your next project, call us collect at 414-468-1000.

. . . "Leaders are made, they are not born; and they are made just like anything else has ever been made in this country - by hard effort. And that's the price that we all have to pay to achieve that goal, or any goal."

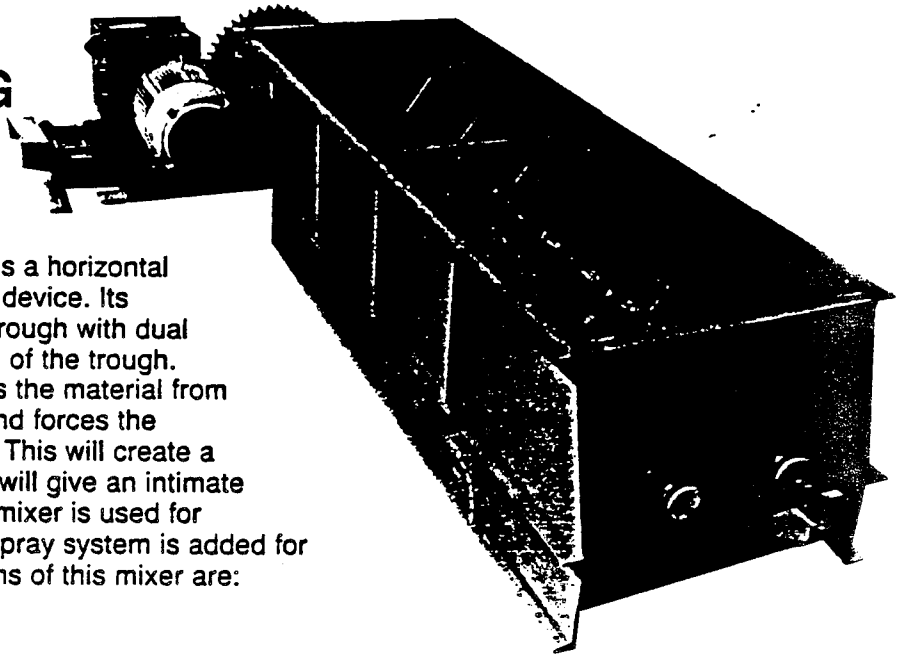
Vince Lombardi
Green Bay Packer Head Coach
1958 — 1968

FEECO INTERNATIONAL, INC.
3913 Algoma Road
Green Bay, Wisconsin 54301
414-468-1000
TELEX: 26-3456 (FEECO GRB)

Brochure #P482/1182

THE FEECO PADDLE MIXER

DESIGN & OPERATING PRINCIPLE



The FEECO International paddle mixer is a horizontal mixing, conditioning and agglomerating device. Its design is based on a horizontal-U-type trough with dual shafts and paddles extending the length of the trough. The action of the pitched paddles moves the material from the bottom of the trough up each side and forces the material back down between the shafts. This will create a kneading and folding over effect, which will give an intimate mixture of materials. Where the paddle mixer is used for conditioning or agglomerating, a liquid spray system is added for dispersing the binder. Typical applications of this mixer are:

TYPICAL APPLICATIONS

MIXING:

FGD scrubber sludge, fly ash, and lime for SO_2 neutralization, municipal sludge and woodchips for composting facilities and other processes combining moist and dry feed materials.

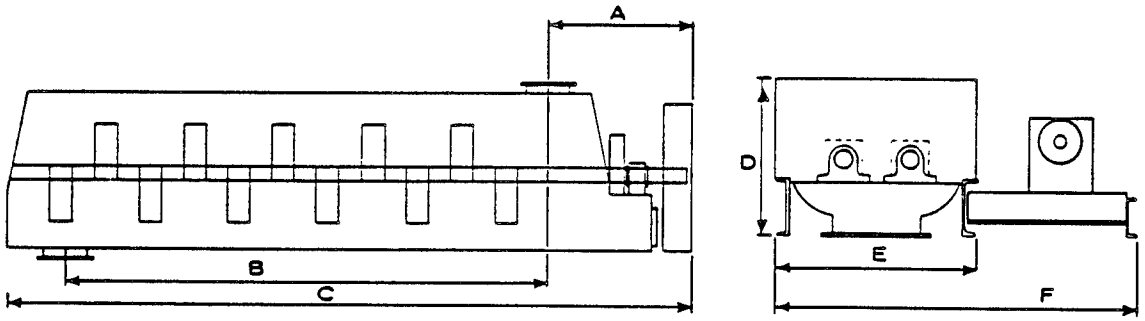
AGGLOMERATION:

Granulation of agricultural chemicals, fertilizers, pesticides, chemical consumer products, carbon powders, flue dust from dust collectors, pigments and dyes.

CONDITIONING:

Fly ash, cement or lime kiln dust, foundry dust, iron-oxide, friction material waste, lead fume, zinc oxide.

SIZING



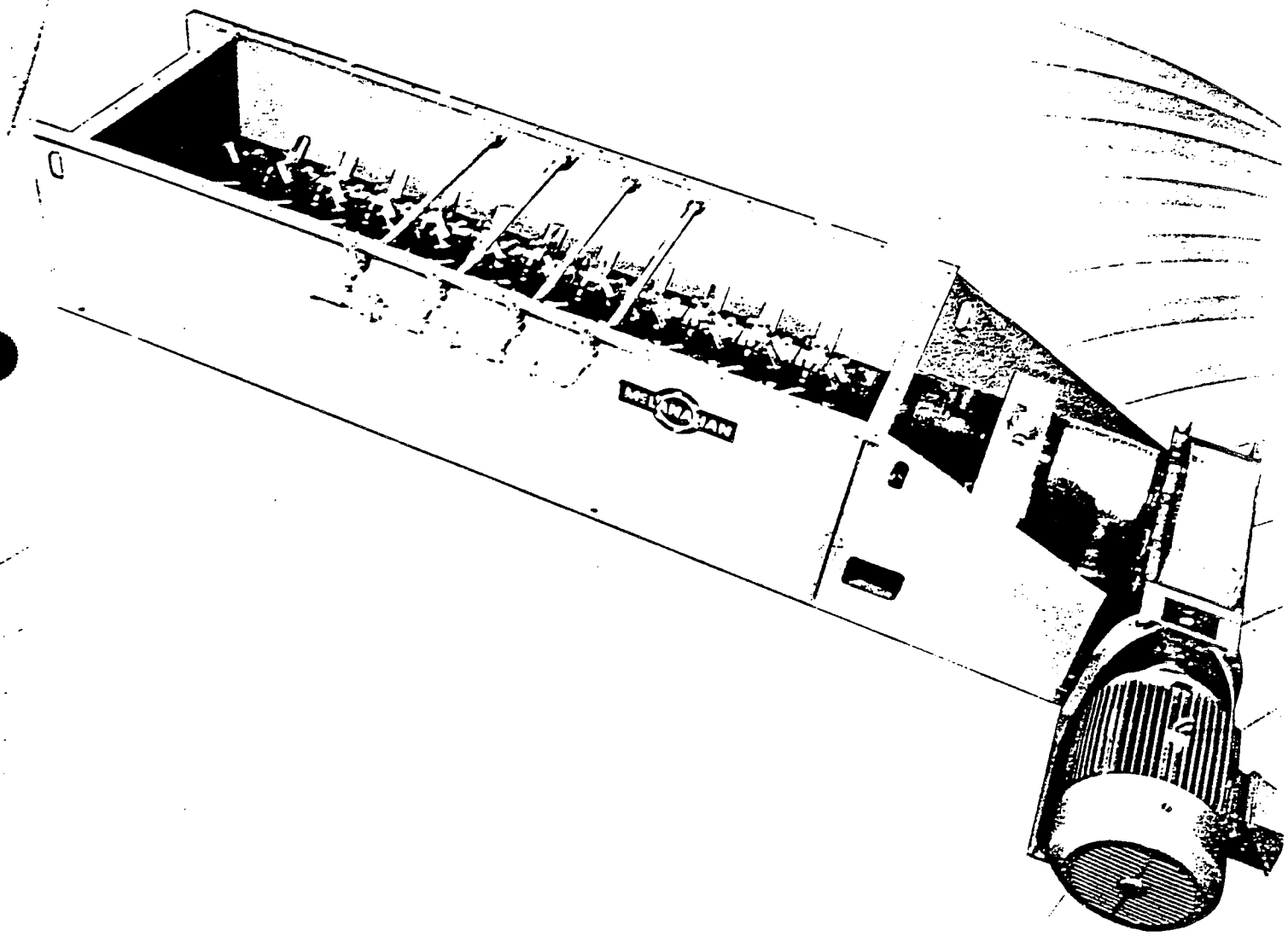
Sizing and Dimensions

Discharge Capacity	10 TPH	30 TPH	75 TPH	125 TPH	175 TPH	225 TPH
Dimension A	3'-2 3/4"	3'-9"	4'-10 1/4"	5'-5 1/2"	3'-9 3/4"	3'-9 3/4"
Dimension B	10'-0 3/4"	10'-4 5/8"	11'-8 1/4"	10'-8 1/2"	11'-0 1/4"	11'-0 1/4"
Dimension C	15'-0"	15'-10"	18'-4 1/2"	18'-6"	16'-3 3/4"	16'-3 3/4"
Dimension D	1'-11 1/8"	2'-7 1/8"	3'-5 1/8"	4'-4 1/8"	4'-9 1/8"	5'-0 1/8"
Dimension E	2'-3 1/2"	3'-3"	4'-6"	5'-6"	6'-7 3/4"	7'-3 1/4"
Dimension F	5'-7"	6'-11 1/4"	8'-2 1/2"	9'-8 1/4"	10'-9 1/2"	11'-7 1/2"

Motor HP: Available from 5 thru 150

Capabilities are based upon dry, fluidized material weighing 40 lbs./Ft.^{3}

McLanahan CORPORATION



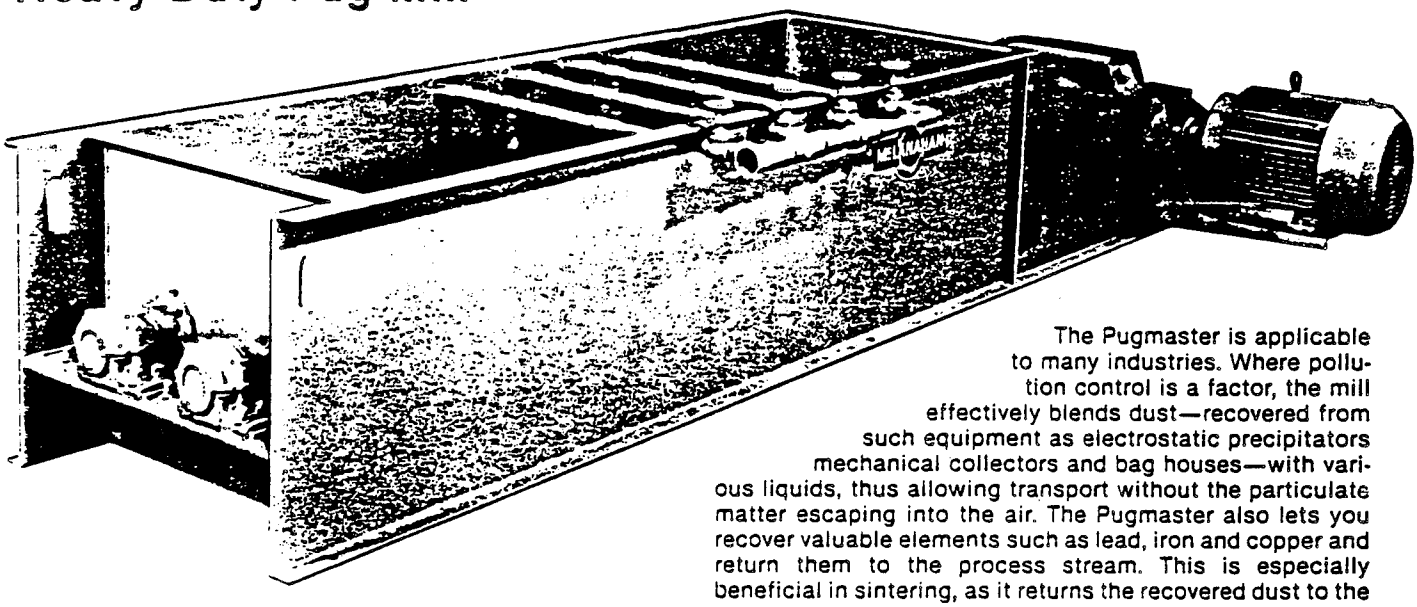
Pug Mills and Mixers

_LS AND MIXERS

Custom Built to Your Needs

McLanahan custom-builds pug mills to fit your specific application because of the many variables that must be considered: capacity requirements, corrosive or abrasive material handling, dust control, moisture content and others. Three basic types of units are described here according to their use: heavy duty, medium duty and coal mixing. All are designed for uniform, continuous feed applications. We will modify these machines or design special machines as necessary to match your specific needs.

PUGMASTER
Heavy Duty Pug Mill



The Pugmaster is applicable to many industries. Where pollution control is a factor, the mill effectively blends dust—recovered from such equipment as electrostatic precipitators mechanical collectors and bag houses—with various liquids, thus allowing transport without the particulate matter escaping into the air. The Pugmaster also lets you recover valuable elements such as lead, iron and copper and return them to the process stream. This is especially beneficial in sintering, as it returns the recovered dust to the process—providing a closed circuit.

Design features and benefits

- The Pugmaster Pug Mill is fabricated from steel plate with a rigid base frame. Removable cover plates provide easy access to internal section.
- Top feed opening can be modified to mate with equipment supplied by other manufacturers.
- Paddle shafts, flanged at both ends, simplify maintenance; permit removal of entire assembly.
- Reversible paddle bases are bolted in pairs to paddle shafts. Abrasion-resistant, bolt-on paddles insure maximum wear life.
- Positive, grease-lubricated dual seals are used on stub shafts where they pass through the mixer box at both feed and discharge ends.
- Timing gears are sealed in a heavy duty oil bath case which features fill and drain points and an oil level gauge. These gears allow for paddle intermeshing which provides a vigorous mixing action.
- The four spray pipes are connected to a common header and are equipped with spray nozzles. Individual control valves meter the proper amount of various wetting agents to each pipe.
- Anti-friction roller bearings support paddle shafts and the split-type bearing housings have taconite seals.
- The pug mill drive features a heavy duty gear reducer equipped with taconite seals. Flexible shaft-type couplings connect the reducer to the timing gears and the motor to the reducer.
- All personnel guards are provided.

PUGMASTER

Size	Capacity TPH @ 100 PCF	Recommended Motor Horsepower	Weight (pounds)	Maximum Feed Size (inches)
18" x 10'	72	60	10,020	2
24" x 12'	160	100	19,460	2½
30" x 15'	300	125	31,200	3
36" x 18'	465	150	34,800	4
44" x 20'	610	200	51,300	4
54" x 24'	850	250	62,400	6
66" x 28'	1450	250	74,800	6

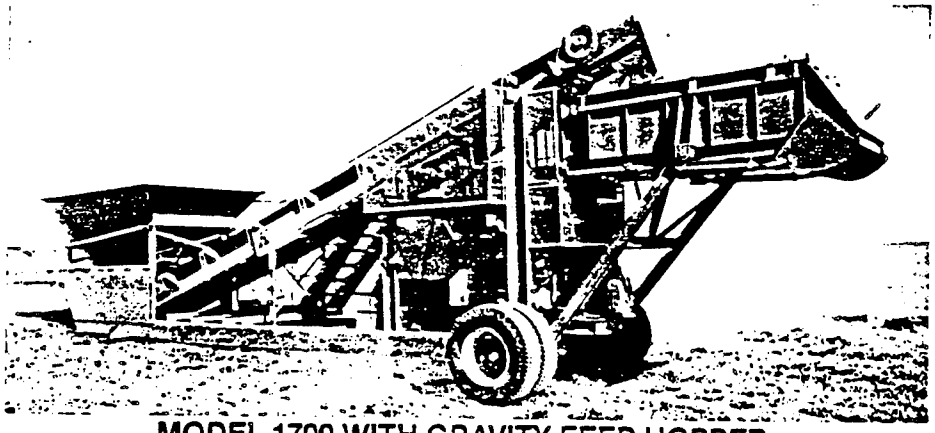
BULLETIN 1700
SERIES 1702-A

PORTEC
Kolberg

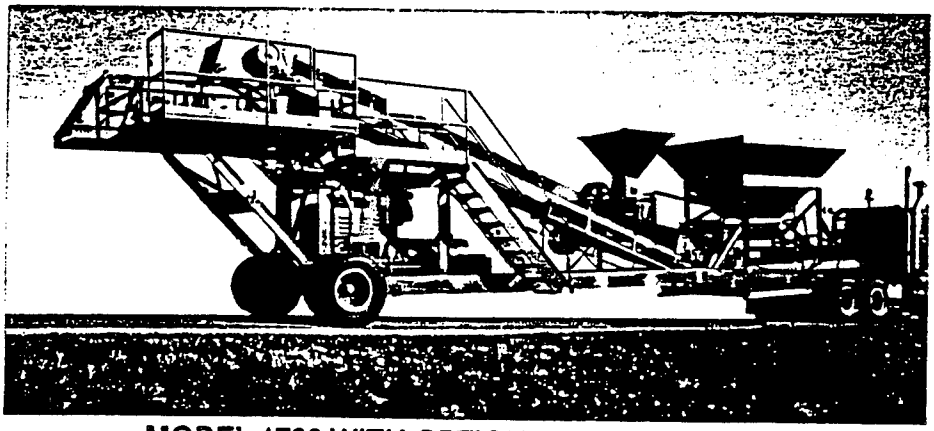
PUGMILL PLANTS FOR LOW COST COLD MIX ROAD BASE AND SURFACE WORK



MODEL 1700 WITH SILT FEEDER / HOPPER COMBINATION



MODEL 1700 WITH GRAVITY FEED HOPPER



MODEL 1700 WITH OPTIONAL VANE FEEDER

Where necessary for purposes of illustration, guards, drives or motors may not have been installed on photos appearing in this brochure.

"TELL US WHAT YOU NEED . . . WE'LL BUILD IT"

PORTEC
Kolberg

PORTEC/KOLBERG PUGMILLS PRODUCE TOP-QUALITY COLD MIX UP TO 300 TPH AND HIGHER

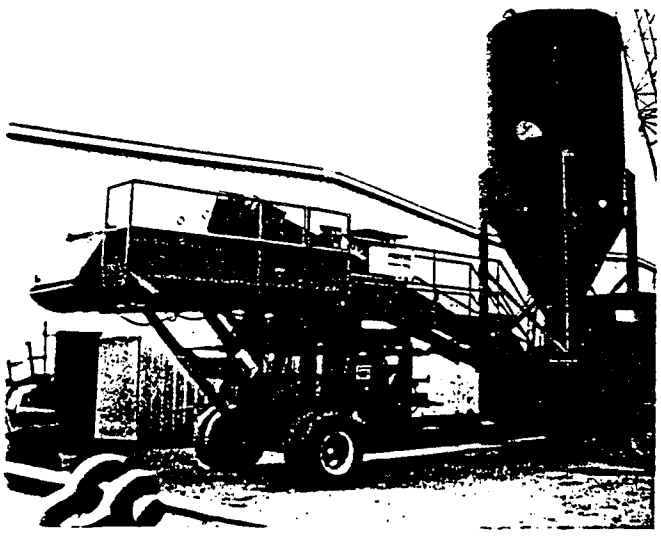


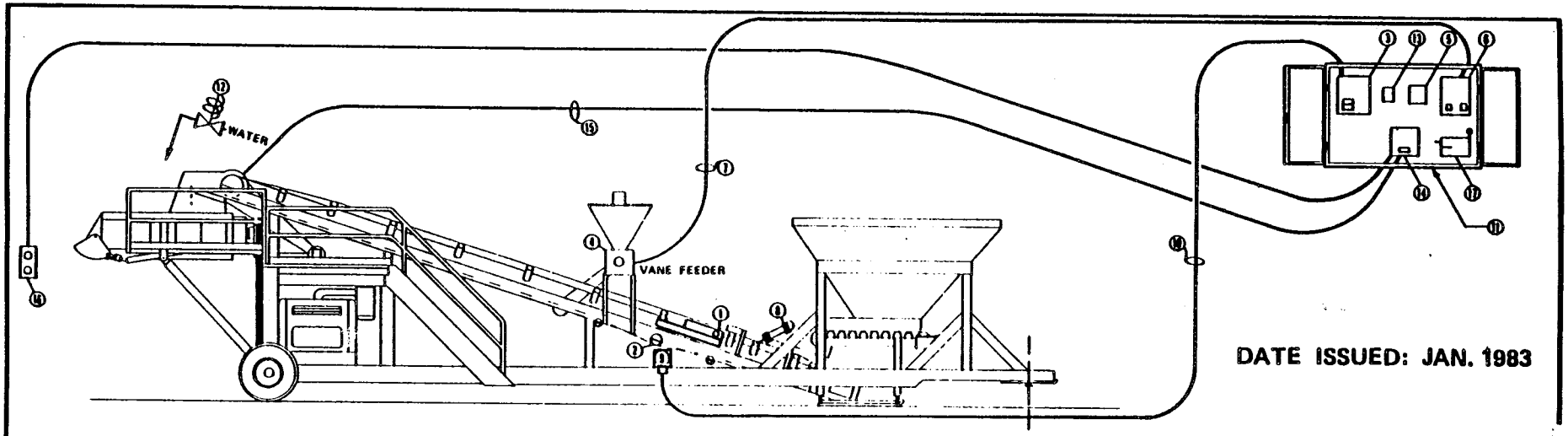
A PORTEC KOLBERG Model 1730 Pugmill mixing reclaimed asphalt materials at Jesup, GA. Unit produces 100 to 150 TPH. A 14-Yd. Gravity Hopper and one-way Grizzly for scalping oversize are features of this plant.

Fast and efficient, low-cost road repair has a strong ally in the new Portec Kolberg Pugmill Plants, portable and stationary models. Not only do these pugmills produce quality cold mix materials at high production rates, but they offer the versatility to apply the various stabilizing agents popularly being used on native and reclaimed materials. Long in use, Portec Kolberg Pugmills can be equipped to add asphalt, lime, cement, fly ash and the other liquid and dry additives, producing a thorough mix for low cost base and surface courses. Complete portability, fast set-up and easy calibration of these plants allow materials to be stockpiled at strategic locations along the road network for important savings in hauling time. All drives, meters and pumps are mounted integral to the plant — nothing has to be removed for transportation purposes. For added versatility, a vibrating screen mounting boom can be installed on these plants, so the pugmill can be replaced by an incline vibrating screen for other uses in the off season.

The plants can also be completely automated: a belt scale and rate of flow display and totalizer readout of the amount of material on the belt conveyor being fed to the pugmill; a rate of flow display (GPM) and totalizer of the asphalt pumped to the pugmill spraybar; automatic proportioning of asphalt to the material being mixed, and an optional truck load-out control by preset counter for daily tonnage and daily truck loads. An optional air-controlled dribble gate provides positive cut-off control to prevent material spillage between loading cycles.

Model 1700 Pugmill with self-supporting Silo and Vane Feeder for adding lime.





DATE ISSUED: JAN. 1983

AUTOMATIC CEMENT TO BASE ROCK (CTB) PROPORTIONING CONTROL SYSTEM AND TRUCK LOAD-OUT SYSTEM WITH RECORDATION (OPTIONAL) for SERIES 1700 PORTABLE PUGMILL PLANT DESCRIPTION AND SPECIFICATIONS

SYSTEM FUNCTION (Standard System):

- Continuously weighs and totalizes the flow of material on the inclined belt conveyor feeding the pug mill. Provides rate of flow display (TPH) and counter for total tons.
- Continuously measures and indicates the rotational speed (RPM) of the cement vane feeder.
- Automatically proportions the cement-to-base rock to a percent set-point that is selectable by the operator.

OPTIONAL EQUIPMENT TO ABOVE STANDARD SYSTEM:

- Truck load-out control: automatically controls the quantity of base rock delivered to truck to a total weight selectable by the operator (or truck driver). Provides key resettable counters for (a) daily tonnage and (b) daily loads or cycles.
- Printer: provides hard-copy record (ticket and/or tape) of load (tons) delivered to each truck on a multi-part form provided by purchaser.
- Water on/off control system.

BILL OF MATERIALS (Standard CTB Control System)

A. Riede Belt Scale System comprised of:

(1) Model WE-12 single idler scale carriage/bridge/load cell assembly for 24", 30", or 36" conveyor.
(2) Model ST-15 lagged return roll with direct-connected, digital belt speed transmitter.
(3) Model 1126-2 electronic totalizer with high resolution up/down calibration counter, electronic calibration and isolated current output for use with cement ratio system.

B. Cement Ratio Control System comprised of:

(4) Tachometer generator for measuring the rotational speed of vane feeder.
(5) Cement vane feeder rpm indicator (mounts in item (11)).
(6) Model IC-10 indicator/controller with percent (cement-t set-point and auto/manual set-point.
(7) 50 foot, heavy-duty cable assembly with quick-disconnect plug for interconnection between (6) and (4).

C. Interlocking and inter-connection wiring materials, comprised of:

(8) Model LS-10 Tip Switch (no-flow detector) with cabling to junction box.
(9) Junction box near scale carriage assembly (1).
(10) 50 foot, heavy-duty cable assembly with quick dis-connect plug for interconnection between (9) and (3).

D. Packaging comprised of:

(11) Surface mount, dust-tight and vandal-proof cabinet in which items (3), (5) and (6) are mounted and wired.

E. Riede factory mechanical and electrical installation; alignment and check-out of items (1) through (11) above.

F. Riede field engineering supervision of start-up, initial calibration and operator training.

OPTIONAL, ACCESSORY EQUIPMENT TO STANDARD CTB CONTROL SYSTEM

G. Water on/off control system comprised of:

(12) 2" Solenoid operated water valve.
(13) Water on/off selector switch (mounted in item (11)).

Special Note: Belt feeder is shown for illustrative purposes only. Also available with gravity feed hopper or with reciprocating plate feeder/hopper combination.

Continued From Previous Page

H. Truck load-out control system comprised of:
- (14) Model WRC-11 load-out control with thumbwheel selectable, load predetermining counter, daily tonnage counter, total loads/cycles counter, emergency stop pushbutton and auto/manual selector switch (mounts in Item (11)).
- (15) 50 foot cable assembly with quick-disconnect plug for interconnection between (14) and the solenoid controlled, air-operated clutch on the conveyor drive.
- (16) Pendant type pushbutton station with 25 foot cable assembly and quick-disconnect plug for driver initiation of truck loading cycle.
- (17) Printer (mounts in Item 11). Prints net weight of rock delivered to each truck load on a multi-part form supplied by purchaser.

Automatic CTB Control System

List price of standard CTB Control System including Items (1) through (11) and also including mechanical and electrical installation of items (1) through (11) at Riede Systems' factory and four (4) days of field engineering service for supervision of start-up, initial calibration and operator training (Travel and living expenses are billed extra at actual cost).

Conveyor Width 24"	CTB-24
Conveyor Width 30"	CTB-30
Conveyor Width 36"	CTB-36

Optional Accessory Equipment

G. Water on/off control system consists of 2" solenoid operated valve (Item 12) and water on/off selector switch (Item 13).

Add . . . . CTB-W

H. Truck Load-out Control System consists of Model WRC-11 load-out control (Item 14), 50 ft. cable assembly (Item 15), pendant type pushbutton station with 25 ft. cable assembly (Item 16) and manually operated ticket printer (Item 17).

Add . . . . CTB-LO

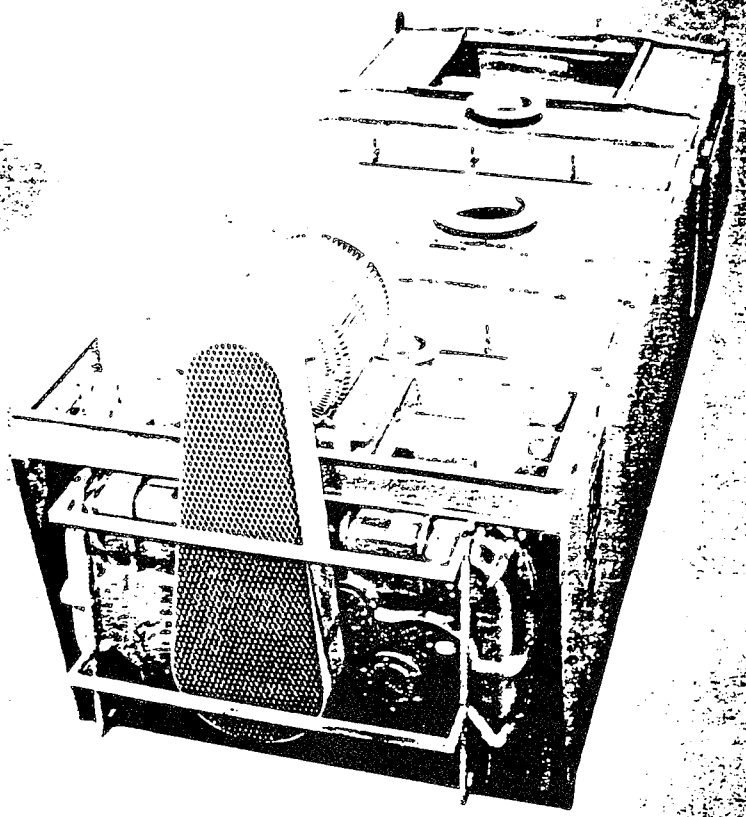
SINCE 1872

EIW

EAGLE IRON WORKS

EAGLE

Pug Mill Mixer



The Eagle Pug Mill Mixer can make SO_2 scrubber sludge disposal a cinch. The Mixer thoroughly blends flue gas desulfurization sludge, fly ash and additives to make superior quality landfill material. In actual field installations, the unit is producing stabilized material with greatly reduced leachability.

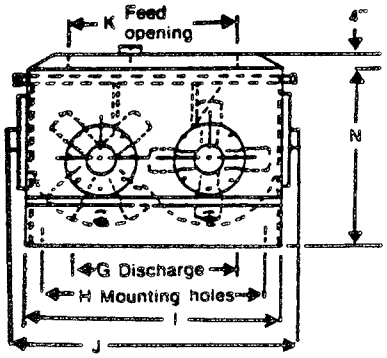
Eagle Mixers are of a proven twin shaft design. Shaft centers have an interlocking pattern of paddles. These paddles provide the mixing action. They are cast of abrasion resistant Ni-Hard chromium-nickle alloy iron with corrugated faces. The paddles can be quickly reversed in pairs to retard material flow and increase mixing action when required. The paddles bolt to spuds welded on the shafts. Counter rotation of the shafts assures maximum blending of materials.

The Eagle Pug Mill Mixer is offered in sizes with capacities from 100 to 350 TPH. Specifications for standard models and a typical installation are listed on the reverse side.

General Catalog Section "H-1"

Choose from t

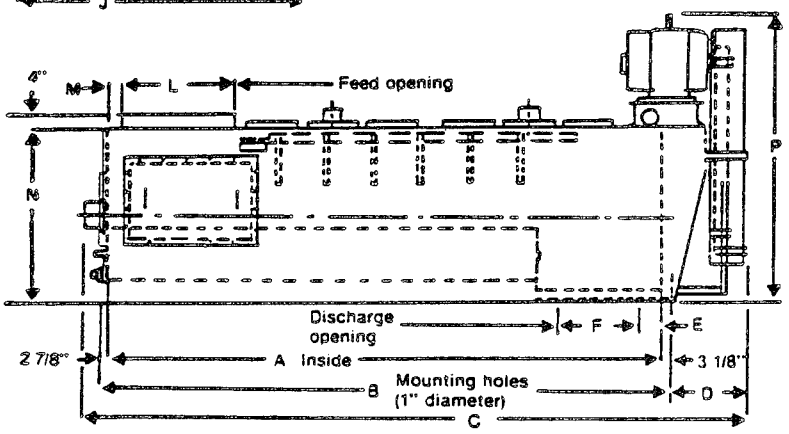
or up to 350 TPH

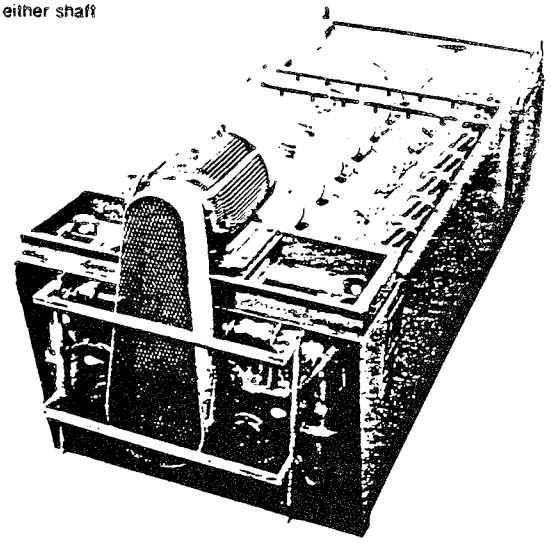


Specifications

Shaft Diameter* (inches)	Capacity (TPH)	Shaft Speed (rpm)	Motor HP	Machine Weight (lb)	Loaded Weight (lb)
27	100	76	75	8400	15950
36	200	60	100	14200	29900
44	350	48	150	23950	55220

*Tip to tip of opposing paddles on either shaft

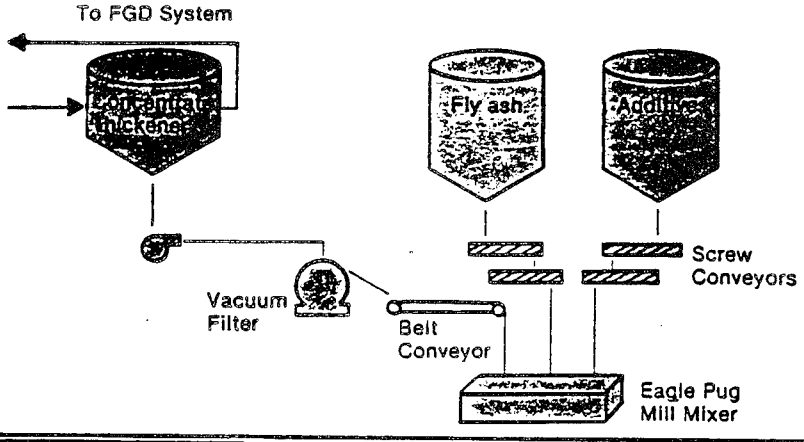




Dimensions

Mixer Size	A	B	C	D	E	F	G	H	I	J	K	L	M	N	P
27"	11'-6"	12'-0"	13'-10 7/8"	1'-6 7/8"	6"	1'-10"	3'-6"	3'-8"	4'-5 1/2"	5'-5"	2'-6"	2'-4"	5 13/16"	3'-3"	5'-11 3/8"
36"	13'-6"	14'-0"	16'-3 1/16"	1'-11 1/16"	6 1/2"	2'-0"	4'-0"	5'-5"	6'-3"	7'-2 1/2"	4'-2"	2'-10"	3 1/2"	4'-5 1/2"	7'-3 3/8"
44"	15'-10"	16'-4"	19'-1 3/4"	2'-5 1/4"	3"	2'-4"	5'-0"	6'-6"	7'-6 1/2"	8'-6"	4'-6"	4'-6"	3"	3'-2 1/2"	8'-3 1/2"

In a typical installation, sludge from the flue gas desulfurization (FGD) system first enters a concentrate thickener. Overflow is pumped back to the FGD system. The SO_2 sludge is pumped through a vacuum filter and fed into the Eagle Mixer. Fly ash and other necessary additives are stored in silos. Screw conveyors are typically used to transport these materials to the Mixer. In the Mixer, all materials are thoroughly blended to produce a stabilized compound which can be stockpiled and eventually used as landill.



SINCE 1872
EIW
EAGLE IRON WORKS

SOLD AND SERVICED BY

A 36" x 13'6" PUG MILL, COMPLETE W/100 HP MOTOR, FOB LIST = $46650 ea
BUDGET PRICE ONLY

EAGLE IRON WORKS, 129 HOLCOMB AVE., DES MOINES, IOWA 50313

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FEECO INTERNATIONAL

FEECO International, Inc. • 3913 Algoma Rd. • Green Bay, WI 54301 • (414) 336-4444 TELEX 26-1456 FEECO GRBY • USA

March 10, 1987

Ref: #277

H.D.R. Infastructure
8404 Indian Hill Drive
Omaha, NE 68114

Attention: Mr. Randy Grachek

Dear Mr. Grachek:

Per your telephone conversation with FEECO's Tim Matzke, I am pleased to offer you the following budget pricing information for pug mill mixers:

TPH *	FEECO MODEL #	SELLING PRICE
15	#2212	$20,000.00
45	#4212	$30,000.00
110	#4812	$38,000.00
185	#6012	$51,000.00
250	#7212	$60,000.00
325	#7812	$75,000.00

* Based on 60 PCF material

The above prices are f.o.b. Green Bay, Wisconsin.

I hope you find this information useful and look forward to working with you on this project.

Sincerely,

FEECO INTERNATIONAL, INC.

Larry M. Cliver
Sales Manager

LMC:kmk

Encl: Mixer Brochure

cc: The J. W. Thompson Co.
10550 Marty Suite 302
Overland Park, Kansas 66212
Attn: Mr. Kevin Hill
913-341-7210

McLanahan CORPORATION

DAVID B. SCHELLBERG
SALES ENGINEER

March 10, 1987

H D R
8404 Indian Hills Drive
Omaha, NE 68114-4049

Attention: Mr. Randy Grachek

THE TERMS AND CONDITIONS SET FORTH ON THE BACK HEREOF SHALL BE CONSIDERED AS BEING A PART OF AND FULLY INCORPORATED IN THIS PROPOSAL

SUBJECT: McLanahan Pugmaster Pug Mill Mixer Pricing

Dear Mr. Grachek:

In response to our conversation of March 5 we are providing pricing to you on a smaller Pug Mill Mixer for a reduced capacity from the Mixer quoted earlier on January 21.

We understand the Mixer is required to handle the following:

Material:	(A)	Hazardous Contaminated Soil
Bulk Density:		90 - 110 Lbs. Per Cu. Ft.
Moisture Content:		20%
Material:	(B)	Power Plant Fly Ash
Bulk Density:		75 Lbs. Per Cu. Ft.

We understand that presently it is not known what ratio of fly ash to soil will be fed through the Mixer.

The 18" x 10' Pugmaster Mixer which we are quoting has a maximum rated capacity of 72 T.P.H. based upon a 100# per cubic foot bulk density of the materials being mixed.

Dimensions for the unit we are quoting can be found on drawing 13-E-50 which was sent to you earlier on January 21. A description and pricing of the unit we are proposing is as follows:

DESIGN FEATURES

The Pug Mill Mixer box is fabricated from steel plate which would be ribbed and flanged for maximum stiffness and rigidity. The feed opening is flanged for attachment of auxiliary chutes or hoppers provided by others. The top plate of the Mixer box is removable for paddle shaft maintenance.

The paddle shafts are fabricated from extra heavy structural steel tubing. These paddle shafts are flanged at both ends for easy removal from the Mixer. Paddle bases are bolted to the paddle shafts at 90 degrees. The Mixer is equipped with high carbon steel paddles which are 1" thick and heat treated to provide a Brinell Hardness of 500 to 600.

The paddle shafts are bolted to flanged stub shafts which are supported in anti friction spherical roller bearings. These bearings are of the split housing design and are equipped with taconite type seals.

Taconite type seals are also provided where the paddle shafts pass through the ends of the Pug Mill Mixer box. These are grease purged seals.

The Pug Mill drive features a heavy duty gear reducer equipped with taconite seals. Flexible shaft type couplings connect the reducer to the timing gears and the motor to the reducer.

Timing gears are sealed in a heavy duty oil bath case which features fill and drain points and an oil level gauge. These gears allow for paddle intermeshing which provides a vigorous mixing action.

PRICING

One - McLanahan 18" diameter x 10' long Pugmaster Pug Mill Mixer, weighing approximately 10,020#, less motor, incorporating design features as outlined above, complete with fabricated steel Mixer box, removable top covers designed for paddle shaft maintenance and removal, fabricated steel paddle shafts with bolt-on steel bases and flanged at both ends for ease of maintenance, high carbon steel 1" thick heat treated paddles, anti friction spherical roller bearing pillow blocks of split housing design equipped with taconite seals, taconite type seals on Mixer box to seal around paddle shafts, heavy duty gear reducer and timing gear drive; less motor, motor controls and feed controls ---------- $45,355.00

MOTOR

We recommend that the above Mixer be driven by a 60 H.P., 1800 R.P.M., NEMA "C" high starting torque electric motor, to be supplied by others.

TERMS

The above price is quoted f.o.b. truck, Hollidaysburg, PA and is firm for a period of 30 days from today's date. Terms, net 30 days.

DELIVERY

Shipment of one Pugmaster Pug Mill Mixer can be made in approximately 6 to 8 weeks after receipt of order and confirming details. This delivery is in accordance with our current production schedule and supplier commitments, subject to review at the time an order is placed.

As we discussed with you, we are most interested in continuing to work with you in supplying a Pug Mill Mixer for your project in Denver.

March 10, 1987

After you have had the opportunity to review our proposal, we would be available to answer any questions you may have.

Very truly yours,

McLANAHAN CORPORATION

David B. Schellberg

DBS/be

McLANAHAN PUG MILL MIXERS

JANUARY 1986

Model Abbreviations:

Pug Mill Mixer --- PMM
Coalmaster Mixer --- CMM
Blendmaster Mixer --- BMM
Single Shaft Mixer --- SSM
Slurry Mixer --- SM
Hydro Blender --- HB

CUSTOMER	LOCATION	SIZE & TYPE	APPLICATION
Boscobel Granite Co.	Richmond, Va.	30" x 8' BMM	Road Base Mixture
Cleveland Elec. Illum.	Willoughby, Ohio	30" x 12' CMM	Coal
Brown Company	Berlin, New Hampshire	8" x 12' HB	Pyrrhotite
E. Long Limited	Orilla, Ontario, Canada	8" x 12' HB	
Bethlehem Steel Co.	Sparrows Point, Md.	8" x 12' HB	Pyrites & Water
Bethlehem Steel Co.	Sparrows Point, Md.	8" x 12' HB	Pyrites & Water
Bethlehem Steel Co.	Sparrows Point, Md.	8" x 12' HB	Pyrites & Water
Saugbrugsforeningen	Norway	6" x 12' HB	Pyrite
Mitsubishi Metal	Yokohama, Japan	6" x 12' HB	Unknown
National Zinc Company	Bartlesville, Okla.	8" x 12' HB	Zinc & Water
National Zinc Company	Bartlesville, Okla.	8" x 12' HB	Zinc & Water
Kaiser Aluminum & Chem.	Gramercy, La.	10" x 25' SM	Bauxite & Water
Kaiser Aluminum & Chem.	Gramercy, La.	10" x 25' SM	Bauxite & Water
Kaiser Aluminum & Chem.	Baton Rouge, La.	10" x 25' SM	Bauxite & Liquor
Kaiser Aluminum & Chem.	Baton Rouge, La.	10" x 25' SM	Bauxite & Liquor
Kaiser Aluminum & Chem.	Baton Rouge, La.	10" x 25' SM	Bauxite & Liquor
Owens-Illinois	Waco, Texas	13" x 12' SSM	Sand, Soda Ash & Limesto
Kennecott Copper Corp.	Garfield, Utah	18" x 10' PMM	Flue Dust
Copper Smelter of the Teniente Expansion Program	Coya, Chile, S.A.	18" x 10' PMM	Flue Dust & Water
St. Joe Minerals Corp.	Herculaneum, Mo.	18" x 10' PMM	Bag House Dust
Calumite, Inc.	Morrisville, Pa.	24" x 12' BMM	Fine Blast Furnace Dust
Orinoco Mining Company	Puerto Ordaz, Venezuela, S. A.	38" x 15' PMM	Iron Ore Dust
Main Sewage Treatment Plant	Camden, N.J.	24" x 12' BMM	Sewage Sludge & Wood Chi
New Jersey Zinc Co.	Palmerton, Pa.	38" x 15' PMM	Zinc Sulphide
Republic Steel Corp.	Warren, Ohio	18" x 10' PMM	Flue Dust
ASARCO	El Paso, Texas	38" x 15' PMM	Silica, Coke Breeze, Lea Bed Mix, Sinter Return & Limestone
U. S. Steel Corporation	Gary, Indiana	18" x 10' PMM	Flue Dust, Iron Ore, Cok & Limestone
U. S. Steel Corporation	Gary, Indiana	18" x 10' PMM	Flue Dust, Iron Ore, Cok & Limestone
U. S. Steel Corporation	Gary, Indiana	18" x 10' PMM	Flue Dust, Iron Ore, Cok & Limestone
U. S. Steel Corporation	Gary, Indiana	18" x 10' PMM	Flue Dust, Iron Ore, Cok & Limestone

CUSTOMER	LOCATION	SIZE & TYPE	APPLICATION
U.S. Steel Corporation	Gary, Indiana	18" x 10' PMM	Flue Dust, Iron Ore, Cok Limestone & Dolomite
U.S. Steel Corporation	Gary, Indiana	18" x 10' PMM	Flue Dust, Iron Ore, Cok Limestone & Dolomite
U.S. Steel Corporation	Gary, Indiana	18" x 10' PMM	Flue Dust, Iron Ore, Cok Limestone & Dolomite
U.S. Steel Corporation	Gary, Indiana	18" x 10' PMM	Flue Dust, Iron Ore, Cok Limestone & Dolomite
U.S. Steel Corporation	Gary, Indiana	20" x 15' SSM	Limestone, Coke Dust & T
U.S. Steel Corporation	Gary, Indiana	20" x 15' SSM	Limestone, Coke Dust & T
U.S. Steel Corporation	Provo, Utah	18" x 10' PMM	Flue Dust, Iron Ore, Cok & Limestone
U.S. Steel Corporation	Provo, Utah	18" x 10' PMM	Flue Dust, Iron Ore, Cok & Limestone
U.S. Steel Corporation	Provo, Utah	18" x 10' PMM	Flue Dust, Iron Ore, Cok Lime, Dolomite & Sinter Fines
U.S. Steel Corporation	Clairton, Pa.	54" x 24' CMM	Coal & Fuel Oil
Inland Steel Company	E. Chicago, Ind.	18" x 10' PMM	Flue Dust
Inland Steel Company	E. Chicago, Ind.	18" x 10' PMM	Flue Dust
Inland Steel Company	E. Chicago, Ind.	18" x 10' PMM	Flue Dust
Missouri Basin Power Plant	Wheatland, Wyo.	30" x 15' PMM	Fly Ash & Sludge
Missouri Basin Power Plant	Wheatland, Wyo.	30" x 15' PMM	Fly Ash & Sludge
U.S. Steel Corporation	Geneva, Utah	44" x 20' CMM	Coal
U.S. Steel Corporation	Dravosburg, Pa.	18" x 10' PMM	Flue Dust, Iron Ore, Cok Limestone, Sinter Fines Dolomite
Centromin - Peru	LaOroya, Peru	38" x 15' PMM	Lead Sinter Mix, Coke
Richard R. Storer & Sons, Inc.	S.Portland, Maine	24" x 12' BMM	Sewage Sludge & Wood Chi
Monroe Metro Area Water Pollution Control Facility	Monroe, Mich.	18" x 10' BMM	Sewage Sludge, Fly Ash & Lime
Union Oil Company	Parachute, Colo.	44" x 20' PMM	Retorted Oil Shale
Chem-Security Systems	Arlington, Ore.	18" x 10' BMM	Soil & Hazardous Liquids
Comox-Strathcona	Courtenay, B.C.	18" x 10' BMM	Sewage Sludge & Wood Chi
Cape May County Composting Facility	Cape May, N.J.	24" x 12' BMM	Sewage Sludge, Sawdust, Recycled Compost
Cape May County Composting Facility	Cape May, N.J.	24" x 12' BMM	Sewage Sludge, Sawdust, Recycled Compost
Royer Foundry & Machine Co.	Kingston, Pa.	24" x 12' BMM	Sewage Sludge & Wood Chi
Cooney, Inc.	Portage, Pa.	30" x 15' BMM	Coal & Filter Cake
Taulman-Weiss Composting System	Columbia, S.C.	24" x 12' BMM	Dewatered Sewage Sludge

CUSTOMER	LOCATION	SIZE & TYPE	APPLICATION
Blue Plains (c/o Bevard Industries)	Washington, DC	24" x 12' BMM	Dewatered Sewage Sludge & Lime
Gloucester County Utilities Authority	West Deptford, N.J.	24" x 12' BMM	Sludge, Lime, Wood Chips
Clinton County Composting Facility	Plattsburgh, N.Y.	36" x 18' BMM	Sewage Sludge, Wood Chips and Recycled Compost
Clinton County Composting Facility	Plattsburgh, N.Y.	36" x 18' BMM	Sewage Sludge, Wood Chips and Recycled Compost
Metropolitan Waste Control Commission	St. Paul, Mn.	24" x 12' BMM	Dewatered Sludge and Lime
City of Akron	Akron, Ohio	36" x 15' BMM	Sewage Sludge, Bark and Sawdust
City of Akron	Akron, Ohio	36" x 15' BMM	Sewage Sludge, Bark and Sawdust
Ft. Lauderdale	Ft. Lauderdale, Fla.	30" x 15' BMM	Sewage Sludge, Wood Chips and Recycled Compost
Ft. Lauderdale	Ft.Lauderdale, Fla.	30" x 15' BMM	Sewage Sludge, Wood Chips and Recycled Compost
Southwest Philadelphia Composting Facility	Philadelphia, Pa.	36" x 18' BMM	Sewage Sludge and Wood Chips
Southwest Philadelphia Composting Facility	Philadelphia, Pa.	36" x 18' BMM	Sewage Sludge and Wood Chips
Southwest Philadelphia Composting Facility	Philadelphia, Pa.	36" x 18' BMM	Sewage Sludge and Wood Chips

FEECO INTERNATIONAL

FEECO International, Inc. • 3913 Algoma Rd. • Green Bay, WI 54301 • 414-468-1000 TELEX: 26-3456 (FEECO GRB) • USA

FEECO INTERNATIONAL, INC.
3913 ALGOMA ROAD,
GREEN BAY, WISCONSIN 54301
PHONE 414 - 468-1000
TELEX 26-3456
Presents This Quotation To:

H. D. R.

8404 INDIAN HILL DRIVE

OMAHA, NEBRASKA 68144-4049

For Your Plant At:

H. D. R.

Covering:

PUG MIXER

DATE JANUARY 21, 1987

FEECO Quote No. R27?-J-178

Your #

EQUIPMENT DESIGNERS AND MANUFACTURERS

FEECO INTERNATIONAL

January 21, 1987

Ref: #R277-J-178

H. D. R.
8404 Indian Hill Drive
Omaha, Nebraska 68144-4049

Attention: Mr. Randy Grachek

Dear Mr. Grachek:

Enclosed is FEECO's quotation covering one (1) Model #6012 pug mixer to mix sand and fly ash at a rate of 170 TPH. The mixture will be 10 parts of sand to one part of fly ash. Included in our quotation is a detailed description of the equipment we plan to furnish.

The total selling price for this pug mixer F.O.B. Green Bay, Wisconsin is $50,636.00. Estimated freight to Denver is $2,500. Delivery on this equipment is 8 to 10 week's after drawing approval.

I hope you find our quotation favorable and if you have any questions or I can be of further service, please do not hesitate to contact me at (414) 468-1000.

Sincerely,

FEECO INTERNATIONAL, INC.

Larry M. Cliver
Sales Manager

LMC:kmk

Encl: Quotation R277-J-178
Brochure P482/1182
Brochure 302

cc: The J.W. Thompson Co.
10550 Marty, Suite 302
Overland Park, Kansas 66212
Attn: Chris Thompson
913/341-7210

FEECO INTERNATIONAL QUOTATION #R277-J-178

H. D. R.
8404 Indian Hill Drive
Omaha, Nebraska 68144-4049

Attention: Mr. Randy Grachek

January 21, 1987

THE FOLLOWING ITEMS QUOTED ARE BASED ON FEECO INTERNATIONAL DESIGNS AND SHOP PRACTICES:

ITEM	DESCRIPTION

1 PUG MIXER:

1A One (1) FEECO International Model #6012 horizontal twin shaft pug mixer, manufactured to the following specifications:

a) One (1) 3/8" thick mild steel trough, nominal size 60" x 12'-0", complete with trough end seals, integral structural steel base, and one (1) flanged discharge spout. Trough ends are slotted for the removal of shafts from the mixer, without removing paddles, gears and bearings from the shafts.

b) T-1 steel paddles mounted on two (2) square shafts with ends turned down for six (6) 5-15/16" bore Dodge roller bearing pillow blocks.

c) Two (2) cut tooth steel pinion gears mounted on the mixer shafts, enclosed in an oil bath type gear casing.

1B One (1) 10 gauge thick mild steel trough cover, fabricated and flanged in three (3) pieces, for FEECO International pug mixer Model #6012. Trough cover includes one (1) flanged inlet only, and spring clips for mounting to trough.

1C Paddles to be complete with hard surface weld on leading edge to minimize wear.

1D One (1) motor, TEFC, 3 phase, 60 cycle, 230/460 volt, 75 HP, 1800 RPM for above.

1E One (1) Dodge or Equal, type TM horizontal concentric reducer, 1800/155 RPM, 75 H.P. Class II with integral scoop type motor mount, flexible motor coupling and coupling guard.

1F One (1) roller chain drive for use with 155 RPM output gear reducer, consisting of one (1) drive sprocket with hardened teeth, one (1) driven sprocket, and RC-200 roller chain with a 1.3 service factor.

1G One (1) oil bath type drive guard fabricated from 12 gauge thick mild steel.

TOTAL NET SELLING PRICE F.O.B. TRUCK
GREEN BAY, WISCONSIN IS: ---------- $50,636.00

ESTIMATED FREIGHT TO DENVER, COLORADO ------- $2,500.00

TERMS: 15% of order amount at time of award
65% of order amount in equal monthly installments
20% of order amount at time of shipment
Net 10 days

Surface Preparation - See FEECO Standard #104A
Paint - See FEECO Standard #S0JD0.PW1
Taxes: By Buyer

Our quotation shall be valid for a period of 30 days. Acceptance of an order during that time period shall be subject to satisfactory credit approval by FEECO International, Inc.

H. D. R.

BY:_____

TITLE:_____

DATE:_____

LMC:kmk

FEECO INTERNATIONAL, INC.

Larry M. Cliver
Sales Manager

FEECO STANDARD FINISH

MANUFACTURER: Rust-Oleum Corporation
11 Hawthorn Parkway
Vernon Hills, Illinois 60061

SPECIFICATION: 1500 System - Modified Alkyd speedy-dry high gloss finish

DESCRIPTION: Tough, high gloss, modified short oil, alkyd finish specially formulated to dry rapidly and provide good color retention, resistance to abrasion and mild chemical fumes, and long-term protection and a hard, durable finish for indoors and out. Rust-inhibiting pigments are incorporated in sufficient amounts to provide corrosion resistant properties while retaining the appearance of a finish coat. Recommended for steel, concrete, masonry and wood, as a production finish for equipment and machinery and maintenance applications where minimum down-time is important.

CHARACTERISTICS: One coat system. Color: National Blue #721

Dry Times @ 70° F., 50% Relative Humidity:

To Touch	-	30 to 60 Minutes
Tack Free	-	1 to 2 Hours
Handle	-	2 to 4 Hours
Hard	-	6 to 8 Hours

Dry Heat Resistance - 212° F.

Recommended Dry Film Thickness: 1-2 Mils

Coverage at Recommended Dry Film Thickness
250 to 300 square feet/gallon

Composition: 34% by Volume
Solvents - Aromatic Hydrocarbons

SURFACE PREPARATION: Commercial Sandblast SSPC-SP6-63 per FEECO Standard #104A.

APPLICATION: Air-Atomized Spray

USAGE: On all equipment manufactured by FEECO to which special customer finish specifications are not applicable.

FEECO INTERNATIONAL, INC.
3913 Algoma Road, Green Bay, WI 54301
Ph. 414/468-1000 Telex 263 456 (Feeco GRB)

FORM #104A
January 12, 1976

COMMERCIAL BLAST CLEANING
SSPC-SP-6-63

SURFACE PREPARATION

This type of blast cleaning will be considered as FEECO'S standard method, unless otherwise specified on the shop order.

Commercial blasting requires removal of all loose scale, rust and other surface contaminants.

When cleaning surfaces previously painted, it is not always advisable to remove that portion of coating in good sound condition. This type of blasting is often called "Shadow Blasting" and in some instances is highly desirable.

In cases when the wrong coating has been applied in error, and if this coating is not compatible with new coating to be applied, the old coating must be removed completely.

Commercial blast cleaning is FEECO operation number 275.

McLanahan CORPORATION

DAVID B. SCHELLBERG
SALES ENGINEER

January 21, 1987
(COURIER)

H D R
8404 Indian Hills Drive
Omaha, NE 68114-4049

Attention: Mr. Randy Grachek

SUBJECT: McLanahan Pugmaster Pug Mill Mixers

Dear Mr. Grachek:

In response to our conversation on Monday, January 19, we are pleased to provide Pug Mill Mixer selection and pricing for the project we have previously discussed with you.

We understand the Mixer is required to handle the following:

Material:	(A)	Hazardous Contaminated Soil
Bulk Density:		90 - 110 Lbs. Per Cu. Ft.
Percent Moisture Content:		20%
	(B)	Power Plant Fly Ash
Bulk Density:		40 Lbs. Per Cu. Ft.

You advised us that the fly ash is to be introduced with the contaminated soil by a screw type feed conveyor and that two machines are required, each to handle 140 T.P.H.

We understand that it is presently not known what the ratio of soil to fly ash will be. We would wish to point out that the 24" x 12' Pugmaster Pug Mill Mixer we are quoting has a maximum rated capacity of 160 T.P.H. based upon 100# per cubic foot bulk density.

Features of Pugmaster Pug Mill Mixers are outlined in the enclosed bulletin PMM-212. Approximate dimensions for the 24" x 12' Mixer we are proposing can be found on drawing 13-E-50. A description and pricing of the unit we are proposing is as follows:

DESIGN FEATURES

The Pug Mill Mixer box is fabricated from steel plate which would be ribbed and flanged for maximum stiffness and rigidity. The sides of the Pug Mill box are designed for removal for paddle shaft maintenance. The feed opening is flanged for attachment of auxiliary chutes or hoppers provided by others. The top plate of the Mixer box is not removable but is furnished with inspection openings.

The paddle shafts are fabricated from extra heavy structural steel tubing. These paddle shafts are flanged at both ends with the flange located outside the Mixer box. Paddle bases are bolted to the paddle shafts at 90 degrees. The Mixer is equipped with high carbon steel paddles which are 1" thick and heat treated to provide a Brinell Hardness of 500 to 600.

The paddle shafts are bolted to flanged stub shafts which are supported in anti friction spherical roller bearings. These bearings are of the split housing design and are equipped with taconite type seals.

Taconite type seals are also provided where the paddle shafts pass through the ends of the Pug Mill Mixer box. These are grease purged seals.

The Pug Mill drive features a heavy duty gear reducer equipped with taconite seals. Flexible shaft type couplings connect the reducer to the timing gears and the motor to the reducer.

Timing gears are sealed in a heavy duty oil bath case which features fill and drain points and an oil level gauge. These gears allow for paddle intermeshing which provides a vigorous mixing action.

PRICING

One - McLananan 24" diameter x 12' long Pugmaster Pug Mill Mixer, weighing approximately 19,460#, less motor, incorporating design features as outlined above, complete with fabricated steel Mixer box, removable flanged side plates designed for paddle shaft maintenance and removal, fabricated steel paddle shafts with bolt-on steel bases and flanged at both ends for ease of maintenance, high carbon steel 1" thick heat treated paddles, anti friction spherical roller bearing pillow blocks of split housing design equipped with taconite seals, taconite type seals on Mixer box to seal around paddle shafts, dual output shaft reducer, heavy duty gear reducer and timing gear drive; less motor, motor controls and feed controls ---------- $74,025.00

MOTOR

We recommend that the above Mixer be driven by a 100 H.P., 1800 R.P.M., NEMA - C high starting torque electric motor, to be supplied by others.

TERMS

The above prices are quoted f.o.b. truck, Hollidaysburg, PA and are firm for a period of 30 days from today's date. Terms, net 30 days.

DELIVERY

Shipment of one Pugmaster Pug Mill Mixer can be made in approximately 14 to 16 weeks after receipt of order and confirming details. This delivery is in accordance with our current production schedule and supplier commitments, subject to review at the time an order is placed.

FREIGHT

Estimated freight to Denver, CO for two 24" x 12' Pugmaster Mixers is $2,000.00. Please note that this rate is only an estimate of anticipated freight charges. Actual rates will be those that are in effect at time of shipment.

January 21, 1987

We would be most interested in working with you further as this project develops. After you have had the opportunity to review this information, please do not hesitate to contact us.

Very truly yours,

McLANAHAN CORPORATION

David B. Schellberg

DBS/be

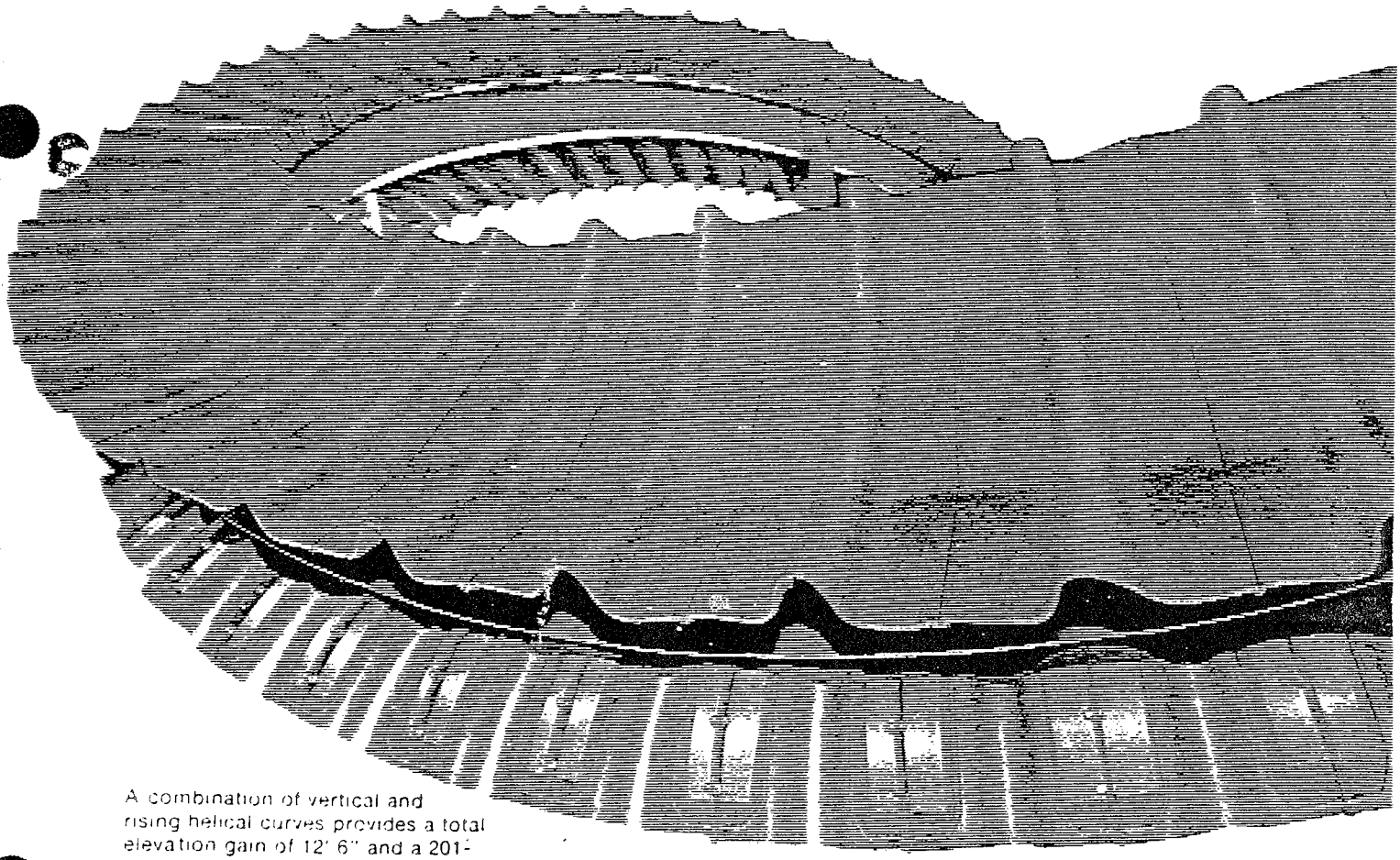
Encl.

SERPENTIX
CONVEYOR CORPORATION

Three Dimensional Continuous Path Conveying Systems

Featuring

- Horizontal, Vertical and Helical Curve Capabilities
- Continuous Path Conveying For Eliminating Multiple Transfer Points
- Flighted Belt Surface That Stretches Flat For Cleaning
- Options/Benefits For Saving Space, Maintenance & Energy



A combination of vertical and rising helical curves provides a total elevation gain of 12' 6" and a 201-degree loop at one end of this Serpentix conveyor installation. At the loading end, two horizontal turns account for an additional 141-degrees of curving. Total centerline length of the conveyor is 61' 5½".

LEACHATE REMOVAL SYSTEM

BASIN F

PERMANENT LEACHATE REMOVAL SYSTEM

The Permanent Leachate Removal System design was based on the use of Air Operated Double Diaphragm (AOD) Pumps submerged in the Waste Pile sumps to remove leachate from the Waste Pile and dispose of it in the Leachate Surface Impoundment. The environment within the Waste Pile Sumps required the selection of pump materials which are resistant to corrosive liquids. AOD pumps were selected for the following reasons: 1) no dynamic seals are exposed to corrosive liquid, 2) no equipment damage in "dry" pumping situations, 3) flow is easily regulated by pressure and air volume adjustments, 4) easy disassembly for inspection and maintenance, and 5) low fluid velocities and resistance to abrasive fluids.

A compressor was selected for supplying air to the AOD pumps which is rated for outdoor use. There is no need for an enclosure structure. Steel pipe was selected to convey air to the AOD pumps and PVC was selected as the pipe material for the conveying of leachate from the sumps to the Leachate Surface Impoundment.

A support structure was designed to facilitate raising and lowering of the pumps in and out of the riser pipes and sumps for maintenance purposes.

Project Basin F	Computed DAK ckd BRL
Subject Hydraulics	Date 5/15/87 Sht. 1 Of 1

Hydraulic
Gradient Calculations:

From previous study on Basin F fluid, head loss through a 4" pipe @ 100 gpm = $\frac{4.63}{2000}$ = .0023 ft/ft
= .23 ft/100 ft

Available head from the leachate pumping locations to the surface impoundment cell = 40 ft.

Maximum run of the pipe = 920 ft

∴ Available gradient = $\frac{40}{920}$ = 0.043 ft/ft

= 4.35 ft/100 ft.

Therefore, there is plenty of slope available for overcoming friction losses in the pipe.

During design, try to maintain at least a .23 ft/100 ft slope to assure adequate flow. This will be conservative since the ~~anticipated~~ design flow is 60 gpm yet the pipe friction loss is based on 100 gpm.

Project Basin F | Computed DAK chk BRL

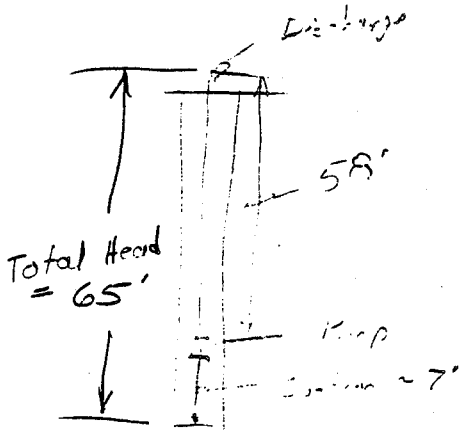
Subject Pump Sizing / TDH Calcs | Date 5/15/87 | Sht. 1 | Of 1

Middle Pump Pumping Head:

(65 ft lift)(1.25 sp. gr.) = 81.25 ft
Static Head

Friction Head Calc's

Previous study on basin F fluid indicated a loss of 4.63 ft/2000 ft at 100 gpm. This is 1.56 times that for water. Assume friction loss is twice that of water.



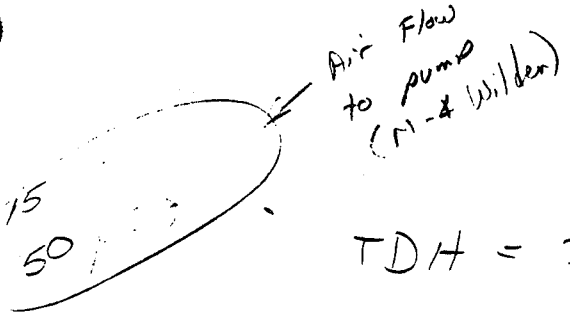
2" Suction: 20 gpm

$2\left[(7\text{ ft})\left(\frac{.83'}{100'}\right)\right] = .12$ ft

1½" Discharge: 20 gpm

$2\left[(58\text{ ft})\left(\frac{2.8'}{100'}\right)\right] = 3.26$ ft

Total Friction = 3.38 ft



TDH = 3.38 + 81.25 = 84.6 ft
Say 85 ft

Other Pumps:

(45 ft lift)(1.25) = 56 ft static

2" Suction @ 20 gpm: Same as above = 0.12 ft

1½" Discharge @ 20 gpm:

$2\left[(38\text{ ft})\left(\frac{2.8'}{100}\right)\right] = 2.14$ ft

Total Frict. = 2.26 ft

TDH = 58.26 ft Say 60 ft

~~13 scfm~~
~~40 psig~~

BRL

HDR Infrastructure
A Centerra Company

EQUIPMENT DATA SHEET

DATE 5/15/97
BY DAK
REVISIONS

DISTRIBUTION
PM
PE
AR
SE
ME
EE
DR
OP

PROJECT NAME: Basin F
PROJECT NUMBER: 4008-02-34

NAME OF EQUIPMENT: Air Operated Diaphragm Pump
I.D. NUMBER:

TYPE OF EQUIPMENT: Pump
LOCATION (BUILDING - LEVEL): In Sumps

DESIGN CONDITION: 20 gpm @ 60' TDH & 85' TDA
SIZE L-W-H: 13½ x 22 x 25 9/16
WEIGHT (lbs): 50# ea pump

MATERIAL OR CONSTRUCTION: Polypropylene Case & Neoprene Diaphragm
~~HEAT DISSIPATED KW / BTU~~
~~VENTILATION REQUIRED YES / NO / AMOUNT~~

ACCESSORIES OR OPTIONS
Level control system as made by Air Pump Co. (APCO) Model 1011C.

FURNISHED W/ EQUIPMENT ☐ DISCONNECT SW ☐ MAG MOTOR STARTER ☐ CONTROL

MANUFACTURER, MODEL NO. ETC: Warren Rupp Model PB 1½-A
PRICE $ Pump 1470 Controls 440 ☐ NET ☒ LIST ☐ APPROX

CONTROL NARRATIVE
Sensing tube connected to control valve senses high water level and starts pump. Pump runs until water level drops in the wet plenum of the pump, at which time air pump speeds up and an overspeed sensor shuts down pump.

20 gpm @ 60' TDH — 35 psig — 18 scfm
20 gpm @ 85' TDH — 47 psig — 1? scfm
Air Req'd

CONDITIONS OF OPERATION ☐ CONTINUOUS ☐ <4 HR / DAY ☐ 4 - 12 HR / DAY

MOTOR DATA
VOLTS_____ PHASE ☐ 1Ø ☐ 3Ø ☐ AC ☐ DC
HP_____ ☐ SINGLE SPEED ☐ TWO SPEED
☐ VARIABLE SPEED TYPE_____
☐ REVERSING
☐ TEFC ☐ OPFG ☐ SEVERE DUTY
☐ EXPLOSION PROOF

MOTOR CONTROL CENTER
START/STOP: ☐ HOA ☐ JOG ☐ KQI ☐ OTHER
INDICATOR LIGHTS: ☐ RUN ☐ OFF ☐ STANDBY

AREA CLASSIFICATION
☐ CLASS 1 DIVISION 1
☐ CLASS 1 DIVISION 2
☐ WET
☐ OUTDOOR
☐ UNCLASSIFIED
☐ CORROSIVE

INFO186

BRL

HDR Infrastructure
A Centerra Company

EQUIPMENT DATA SHEET

DATE 5/15/87
BY DAK
REVISIONS

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PROJECT NAME: Basin F
PROJECT NUMBER: 4008-02-34

NAME OF EQUIPMENT: Air Operated Diaphragm Pump
I.D. NUMBER:

TYPE OF EQUIPMENT: Pump
LOCATION (BUILDING - LEVEL): In Sumps

DESIGN CONDITION: 20 gpm @ 60'TDH & 85'TDH
SIZE L-W-H: 11¾ x 14½ x 18"
WEIGHT (lbs): 35

MATERIAL OR CONSTRUCTION: Polypropylene Case/Neoprene Diaphragm/Bronze Air Valve
~~HEAT DISSIPATED KW / BTU~~
~~VENTILATION REQUIRED YES / NO / AMOUNT~~

ACCESSORIES OR OPTIONS
Level Control system as manufactured by Air pump Co. (ARCO) Model 1011C.

FURNISHED W/ EQUIPMENT ☐ DISCONNECT SW ☐ MAG MOTOR STARTER ☒ CONTROL

MANUFACTURER, MODEL NO. ETC: Wilden M-4 elastomeric pump.
PRICE: Pump $ 1195 Controls -0-
☐ NET ☒ LIST ☐ APPROX

CONTROL NARRATIVE
Sensing line connected to control valve senses high level and starts pump. Pump runs until water level drops to ~~the~~ set elevation at the suction pipe. At that time, the pump shuts up and ~~the~~ an overspeed sensor shuts down pump.

Air Required: 20 gpm @ 60' TDH — 13 scfm @ 40 psig; 20 gpm @ 85' TDH — 15 scfm @ 50 psig

CONDITIONS OF OPERATION ☐ CONTINUOUS ☐ <4 HR / DAY ☐ 4 - 12 HR / DAY

MOTOR DATA
VOLTS_____ PHASE ☐ 1Ø ☐ 3Ø ☐ AC ☐ DC
HP_____ ☐ SINGLE SPEED ☐ TWO SPEED
☐ VARIABLE SPEED TYPE_____
☐ REVERSING
☐ TEFC ☐ OPFG ☐ SEVERE DUTY
☐ EXPLOSION PROOF

MOTOR CONTROL CENTER
START/STOP: ☐ HOA ☐ JOG ☐ KQI ☐ OTHER
INDICATOR LIGHTS: ☐ RUN ☐ OFF ☐ STANDBY

AREA CLASSIFICATION
☐ CLASS 1 DIVISION 1
☐ CLASS 1 DIVISION 2
☐ WET
☐ OUTDOOR
☐ UNCLASSIFIED
☐ CORROSIVE

9/28/83

MODEL 1011C LEVEL CONTROL INSTALLATION & OPERATION

Application

THE MODEL #1011C LEVEL CONTROL IS DESIGNED FOR USE WITH AIR OPERATED SUMP PUMPS WHERE A WIDE ON-OFF DIFFERENTIAL IS REQUIRED. PUMP ON AND OFF POINTS ARE CONTROLLED INDEPENDENTLY, SUCH THAT ONE MAY BE CHANGED WITHOUT AFFECTING THE OTHER. WHILE THE MINIMUM DIFFERENTIAL FOR THE #1011C IS 5 INCHES, THE MAXIMUM IS VIRTUALLY UNLIMITED. THE #1011C IS BOTH FLOATLESS AND NONELECTRIC, MAKING IT SUITABLE FOR HAZARDOUS LOCATIONS. INSTRUMENT QUALITY AIR IS NOT REQUIRED, NOR DOES THE UNIT CONSTANTLY BUBBLE AIR INTO THE SUMP.

Operation

THE #1011C CONSISTS OF TWO BASIC PARTS: A LEVEL SENSOR, AND AN OVERSPEED CONTROL. THE LEVEL SENSOR STARTS THE PUMP AT THE HIGH LEVEL DESIRED. THE OVERSPEED CONTROL STOPS THE PUMP WHEN THE LIQUID LEVEL FALLS BELOW THE END OF THE PUMP SUCTION, AND THE PUMP BEGINS TO RUN DRY.

Mounting

MOUNT THE SENSING TUBE ON THE PUMP SUCTION LINE USING TWO STAINLESS STEEL HOSE CLAMPS AND THE BRACKET PROVIDED. NOTE THE "OPEN" MARK ON THE SIDE OF THE SENSING TUBE. THIS IS THE POINT AT WHICH THE PUMP WILL START. MAKE SURE THAT THE PUMP SUCTION PIPE TERMINATES AT THE DESIRED LOW LIQUID LEVEL. A SUCTION STRAINER IS RECOMMENDED TO PROVIDE PUMP PROTECTION. THE #1011C CONTROL BOX SHOULD BE MOUNTED ON A WALL CLOSE TO THE PUMP. FOUR MOUNTING HOLES FOR 5/16" BOLTS ARE PROVIDED.

Piping

PIPE FILTERED-REGULATED-LUBRICATED AIR SUPPLY TO THE 3/4" NPTF INLET PORT ON THE #1011C. PIPE FROM OUTLET PORT TO THE AIR INLET ON THE PUMP BEING CONTROLLED. CONNECT THE SENSING TUBE TO THE CONTROL USING 3/8" OD NYLON TUBING (25 FEET SUPPLIED). DO NOT KINK TUBING. MAKE SURE ALL CONNECTIONS ARE AIR TIGHT.

Start Up

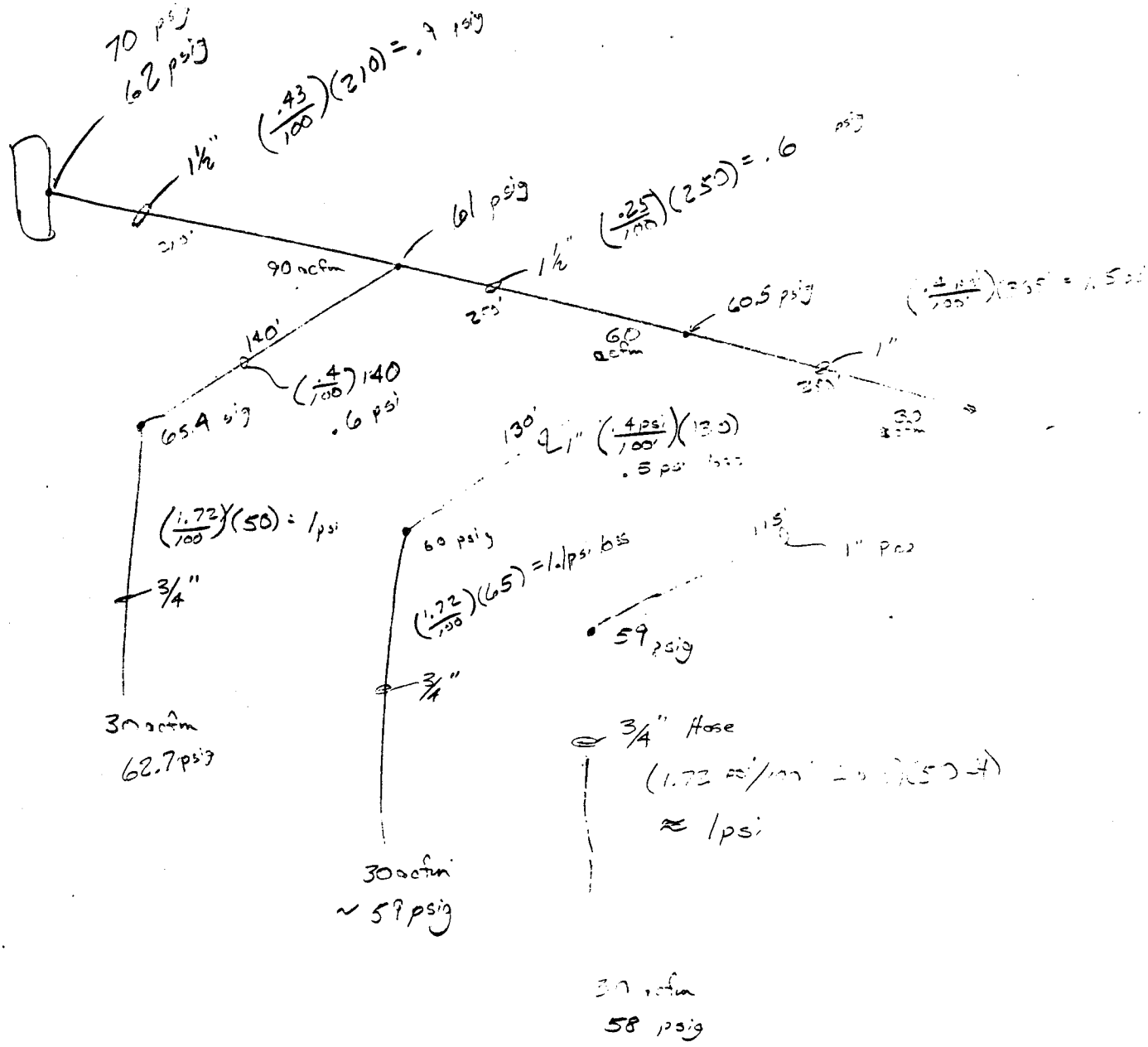
(1) FILL SUMP WITH LIQUID UNTIL LEVEL IS SLIGHTLY BELOW SENSING TUBE.
(2) UNLOCK SHUT OFF SPEED ADJUSTMENT KNOB AND TURN COUNTERCLOCKWISE UNTIL LOOSE.
(3) TURN ON AIR SUPPLY TO SYSTEM. PUMP WILL START.
(4) WITH PUMP OPERATING AT DESIRED SPEED AND PUMPING LIQUID, SLOWLY TURN SHUT OFF SPEED ADJUSTMENT KNOB CLOCKWISE UNTIL PUMP STOPS. BACK KNOB OFF 1/4 TURN COUNTERCLOCKWISE AND LOCK IN POSITION. PUMP WILL REMAIN OFF.
(5) ADD LIQUID TO THE SUMP UNTIL THE LEVEL IS ABOVE THE OPEN MARK ON THE SENSING TUBE. THE PUMP WILL START AND CONTINUE TO RUN UNTIL IT BREAKS SUCTION AND SPEEDS UP.

NO FURTHER ADJUSTMENT OF THE #1011C SHOULD BE REQUIRED UNLESS AIR SUPPLY PRESSURE OR DISCHARGE HEAD IS CHANGED. THE MANUAL OVERIDE BUTTON MAY BE DEPRESSED TO CHECK PUMP OPERATION.

MAILING ADDRESS
P.O. BOX 806
GRAND BLANC, MI 48439
(313) 695-0000

SHIPPING ADDRESS
6503 S. LINDEN RD.
SWARTZ CREEK, MI 48473
(313) 655-6555

Project	Basin F	Computed	DAK	Ckd	BRL
Subject	Pump Air Piping	Date	5/18/97	Sht.	1	Of



Air density & temperature factor:

① 5000' 0°F F = 1.04

② 5000' 100°F F = 1.27

18 Scfm × 1.27 = 25.4 acfm use 30 acfm

Use compressor rated to deliver 120 scfm at a minimum 70 psig.

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EQUIPMENT DATA SHEET

DATE 5/14/87
BY PKO
REVISIONS 5/14/87

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PROJECT NAME

PROJECT NUMBER

NAME OF EQUIPMENT: Air Compressor

I.D. NUMBER

TYPE OF EQUIPMENT: Recip

LOCATION (BUILDING - LEVEL): Outside

DESIGN CONDITION: 120.5 acfm @ 125 psi

SIZE L-W-H: 4w. 9'6" x 5'6" x ~~9'x2'10"x 4'1"~~

WEIGHT (lbs): 3500

MATERIAL OR CONSTRUCTION: Standard

HEAT DISSIPATED KW / BTU

VENTILATION REQUIRED YES / NO / AMOUNT

ACCESSORIES OR OPTIONS

Crankcase Heater
Oil Bath Filter
High Air Temp Shut Down
Low Oil Level Protection
Solnoid Unloader
Nema 4 Control Panel w/ Starters
Heated Trap on Aftercooler
80 Gal. Receiver w/ Fittings, Relief & Pressure Gauge
Heated Trap on Receiver

FURNISHED W/ EQUIPMENT ☐ DISCONNECT SW ☐ MAG MOTOR STARTER ☐ CONTROL

MANUFACTURER, MODEL NO. ETC: Ingersoll-Rand Model M-30

PRICE: $ 14,000 ☐ NET ☐ LIST ☐ APPROX

CONTROL NARRATIVE

CONDITIONS OF OPERATION ☐ CONTINUOUS ☐ <4 HR / DAY ☐ 4 - 12 HR / DAY

MOTOR DATA
VOLTS 480 PHASE ☐ 1φ ☑ 3φ ☐ AC ☐ DC
HP 35 ☐ SINGLE SPEED ☐ TWO SPEED
☐ VARIABLE SPEED TYPE_____
☐ REVERSING
☐ TEFC ☐ OPFG ☐ SEVERE DUTY
☐ EXPLOSION PROOF

MOTOR CONTROL CENTER
START/STOP: ☐ HOA ☐ JOG ☐ KOI ☐ OTHER
INDICATOR LIGHTS: ☐ RUN ☐ OFF ☐ STANDBY

AREA CLASSIFICATION
☐ CLASS 1 DIVISION 1
☐ CLASS 1 DIVISION 2
☐ WET
☐ OUTDOOR
☐ UNCLASSIFIED
☐ CORROSIVE

INFO186

BRL

HDR Infrastructure
A Centerra Company

EQUIPMENT DATA SHEET

DATE 5/14/87
BY PKO
REVISIONS

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PROJECT NAME

PROJECT NUMBER

NAME OF EQUIPMENT: Air Compressor
I.D. NUMBER

TYPE OF EQUIPMENT: Recip
LOCATION (BUILDING - LEVEL): Outside

DESIGN CONDITION: 120.5 acfm @ 125 psi
SIZE L-W-H: 7'X 2'-10"X 4'-1"
WEIGHT (lbs)

MATERIAL OR CONSTRUCTION: Standard
HEAT DISSIPATED KW / BTU
VENTILATION REQUIRED YES / NO / AMOUNT

ACCESSORIES OR OPTIONS
Crankcase Heater
Oil Bath Filter
High Air Temp Shut Down
Low Oil Level Protection
Solnoid Unloader
Nema 4 Control Panel w/ Starters
Heated Trap on Aftercooler
80 Gal. Receiver w/ Fittings, Relief & Pressure Gauge
Heated Trap on Receiver

FURNISHED W/ EQUIPMENT ☐ DISCONNECT SW ☐ MAG MOTOR STARTER ☐ CONTROL

MANUFACTURER, MODEL NO. ETC: Ingersoll-Rand Model M-30
PRICE: $ 14,000 ☐ NET ☐ LIST ☐ APPROX

CONTROL NARRATIVE

CONDITIONS OF OPERATION ☐ CONTINUOUS ☐ <4 HR / DAY ☐ 4 - 12 HR / DAY

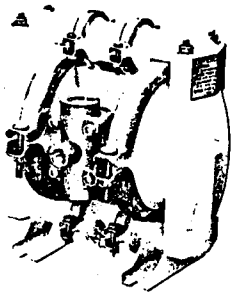
MOTOR DATA
VOLTS 480 PHASE ☐ 1ø ☒ 3ø ☐ AC ☐ DC
HP 35 ☐ SINGLE SPEED ☐ TWO SPEED
☐ VARIABLE SPEED TYPE_____
☐ REVERSING
☐ TEFC ☐ OPFG ☐ SEVERE DUTY
☐ EXPLOSION PROOF

MOTOR CONTROL CENTER
START/STOP: ☐ HOA ☐ JOG ☐ KQI ☐ OTHER
INDICATOR LIGHTS: ☐ RUN ☐ OFF ☐ STANDBY

AREA CLASSIFICATION
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INFO186

SPECIFICATIONS AND PERFORMANCE



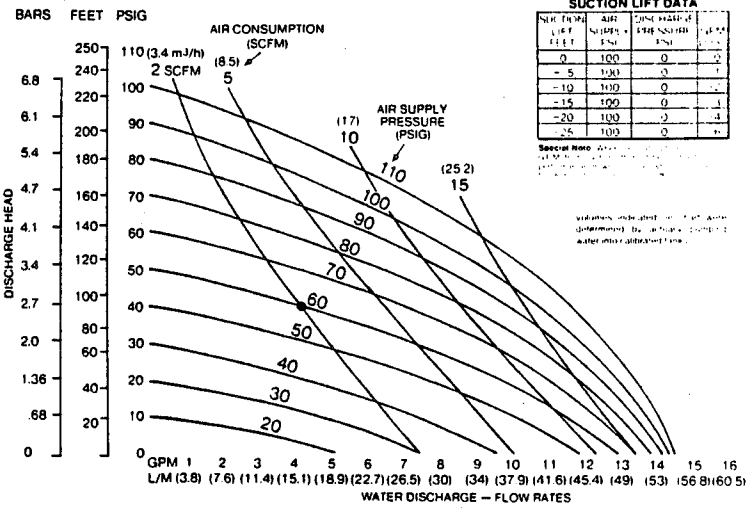
M-1
For Flows to 14 GPM

WILDEN® MODEL M1®

Height ..... 8½"
Width ..... 8"
Depth ..... 6½"
Weight ..... 8 lbs.
Air Inlet ..... ¼" Female N.P.T.
Inlet ..... ½" Female N.P.T.
Outlet ..... ½" Female N.P.T.
Suction Lift POLY { 15' Dry / 25' Wet
TEFLON { 8' – 10' Dry / 25' Primed
Max. Size Solids .. [illegible]" Dia.

Example: *To pump 4 gpm against a discharge pressure of 40 psig requires 60 psig and 2 scfm air consumption. (See dot on chart.)*

Caution: Do not exceed 100 psig air supply pressure.

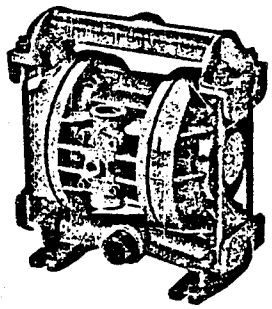


SUCTION LIFT DATA

SUCTION LIFT FEET	AIR SUPPLY PSI	DISCHARGE PRESSURE PSI	GPM
0	100	0	0
– 5	100	0	1
–10	100	0	2
–15	100	0	3
–20	100	0	4
–25	100	0	5

Special Note: [illegible]

[illegible] determined by [illegible] water when calibrated [illegible]



M-2
For Flows to 37 GPM

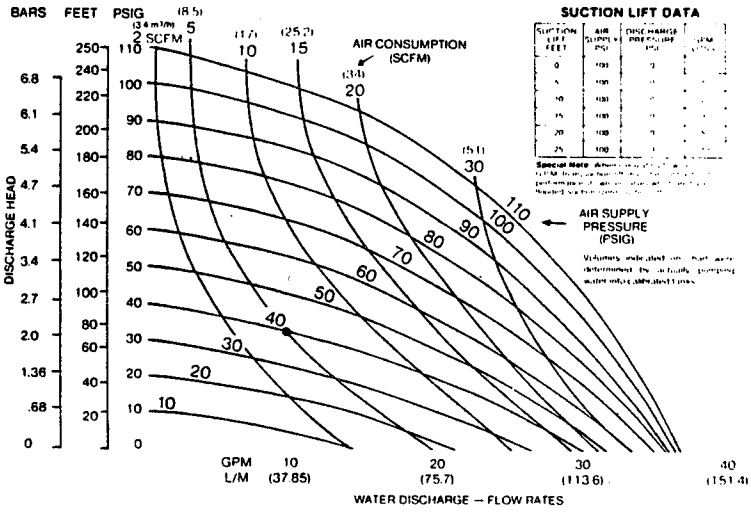
WILDEN® MODEL M2®

Height ..... 10½"
Width ..... 10½"
Depth ..... 7"
Weight .. ALUMINUM 22 lbs.
STAINLESS/HASTELLOY 35 lbs.
Air Inlet ..... ¼" N.P.T.
Inlet ..... 1" Male N.P.T.
Outlet ..... ¾" Male N.P.T.
Suction Lift ..... 18' Dry / 25' Wet
Max. Size Solids .. ⅛" Dia.

Example: *To pump 10 gpm against a discharge pressure of 35 psig requires 40 psig and 5 scfm air consumption. (See dot on chart.)*

Note: For M2 pumps fitted with Teflon diaphragms reduce water discharge figures by 20%. Suction lift for M2 pumps with Teflon diaphragms: 10 ft. dry, 25 ft wet.

Caution: Do not exceed 125 psig air supply pressure.

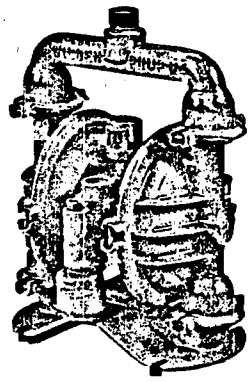


SUCTION LIFT DATA

SUCTION LIFT FEET	AIR SUPPLY PSI	DISCHARGE PRESSURE PSI	GPM
0	100	0	0
5	100	0	2
10	100	0	3
15	100	0	4
20	100	0	5
25	100	0	6

Special Note: [illegible]

[illegible] determined by [illegible] water when calibrated [illegible]



M-4
For Flows to 73 GPM

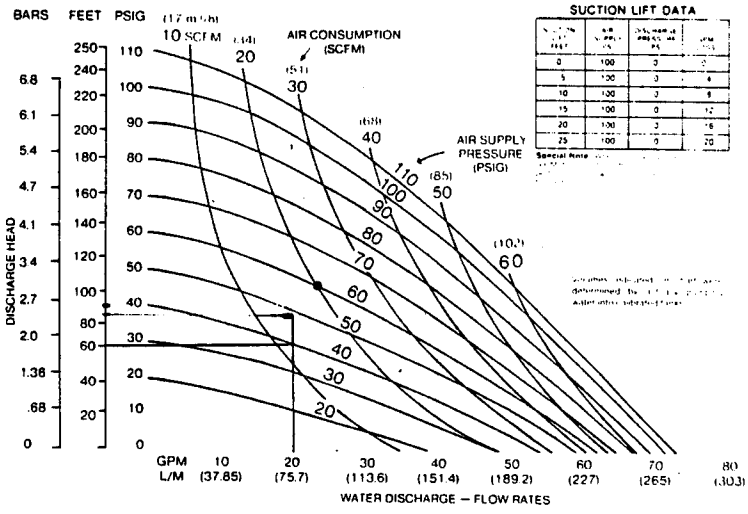
WILDEN® MODEL M4®

Height ..... 18"
Width ..... 14¼"
Depth ..... 11¾"
Weight ..... ALUMINUM 35 lbs.
IRON OR STAINLESS 52 lbs.
Air Inlet ..... ⅜" N.P.T.
Inlet ..... 1½" Female N.P.T.
Outlet ..... 1¼" Male N.P.T.
Suction Lift ..... 22' Dry / 27' Wet
Max. Size Solids .. 3/16" Dia.

Example: *To pump 22.5 gpm against a discharge pressure head of 45 psig, requires 60 psig and 20 scfm air consumption. (See dot on chart.)*

Note: For M4 pumps fitted with Teflon diaphragms reduce water discharge figures by 20%. Suction lift for M4 pumps with Teflon diaphragms: 12 ft. dry, 25 ft. wet.

Caution: Do not exceed 125 psig air supply pressure.



SUCTION LIFT DATA

SUCTION LIFT FEET	AIR SUPPLY PSI	DISCHARGE PRESSURE PSI	GPM
0	100	0	0
5	100	0	4
10	100	0	8
15	100	0	12
20	100	0	16
25	100	0	20

Special Note: [illegible]

[illegible] determined by [illegible] water when calibrated [illegible]

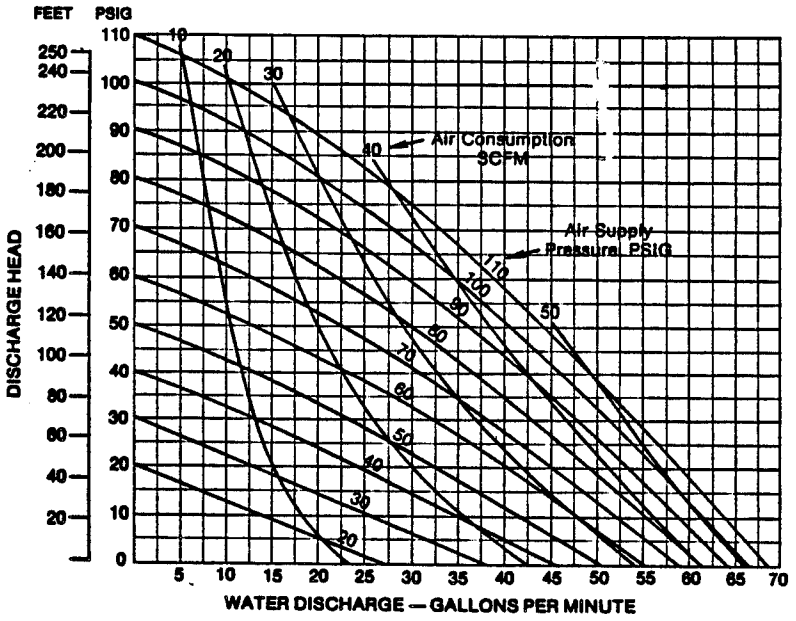
SPECIFICATIONS AND PERFORMANCE

WILDEN MODEL M-4

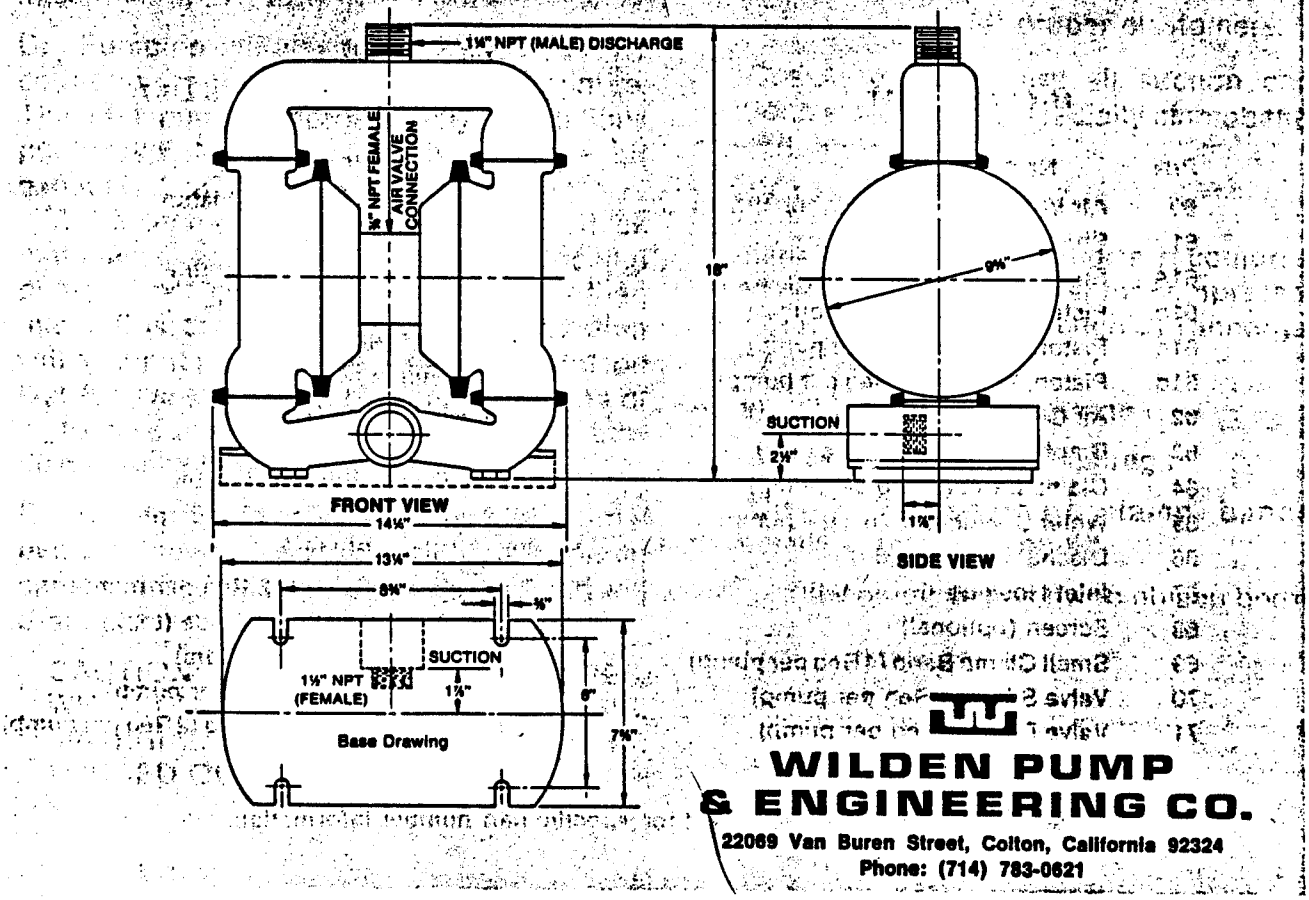
Height ..... 18"
Length ..... 13⅜"
Width ..... 14¼"
Weight . ALUMINUM 35 lbs.
IRON OR STAINLESS 52 lbs.
Air Inlet ..... ⅜" N.P.T.
Inlet . 1½" Female N.P.T.
Outlet . 1¼" Male N.P.T.
Suction Lift ..... 22' Dry
27' Wet
Max. Size Solids 3/16" Dia.

Find performance at intersection of Air Consumption curve with Air Supply Pressure Curve.

Example: With 100 PSIG inlet pressure and 40 SCFM air consumption, water discharge is 34.5 GPM against a head of 60 PSIG.



CERTIFIED DIMENSION DRAWING MODEL M4



WILDEN PUMP & ENGINEERING CO.
22069 Van Buren Street, Colton, California 92324
Phone: (714) 783-0621

Litho U.S.A. 1/78

BASIN F

ELECTRICAL

The design intent is to provide power to an equivalent 35 HP Air Compressor at Basin F. It was determined that the most readily available power source is an existing 13.8 KV overhead line, located approximately 6800 FT from the compressor. Due to the length of run, 480 volt distribution is not feasible because of the excessive voltage drop in the conductors, therefore a direct buried, underground medium voltage cable is proposed to provide power to a pad-mount, oil-filled distribution transformer located 440 FT from the Air Compressor.

The lowest KVA rated commercially available three phase pad-mount transformer with integral primary switch and secondary circuit breaker is utilized. Although, this type of transformer is oversized for the application, this equipment is more suitable for the environment, and provides a less complex, less expensive installation than the alternatives that could provide a lower, but sufficient KVA rating. These are three single phase oil-filled pad-mount transformer with separate primary switch and separate secondary circuit breaker or a three phase dry-type transformer in an outdoor enclosure with separate primary switch and separate secondary circuit breakers.

From the transformer, 480 volt power is supplied to the compressor assembly through direct buried, underground low voltage (600 v) conductors adequately sized to compensate for voltage drop.

High level alarm signals are brought from the wells in Basin F to the compressor alarm panel over pairs of control wires oversized to provide

physical strength for the length of pull. These conductors are run in schedule 40 PVC conduit attached to the piping that is run to each well. Junction boxes are provided at strategic locations to facilitate pulling the conductors and in some instances to provide an enclosure for wire splices.

System protection consists of a fused group operated switch and surge arrestors at the transition from overhead to underground distribution, weak-link primary fuses for transformer fault protection and integral to the transformer, and a thermal-magnetic transformer secondary circuits and the secondary conductors against sustained overloads.

The selection of protective devices and conductors is in accordance with the latest editions of the "National Electrical Safety Code" (ANSI C2), and the "National Electrical Code" (NFPA 70).

HDR

PROJECTS Basin F

SUBJECT Electrical Calcs

COMPUTED Maycock CHECKED [illegible] DATE 5-15-87 PAGE 1 OF 7

FEEDER TO COMPRESSOR PANEL:

EQUIVALENT OF 35HP (2 MOTORS REQUIRED, 1 KNOWN AT 30 HP AND THE OTHER ANTICIPATED TO BE 1 HP, PER P.F.O. 5-14-87)

CALCULATE LOAD BASED ON 1-30HP @ 480V ⇒ 40A

1-5HP @ 480V ⇒ 7.6A

47.6A X 1.25 = 59.5A

could use #6 conductors

USE 60A, 3P C.B.

LENGTH OF RUN:

ASSUME 40' POLE

MOUNT XFMR AT 30'

BURY CABLE AT 2' (2½' M.V.)

RUN 1920' + 1240' + 2400' + 840' + 440' = 6840'

UP TO CABINET 4'

30
2
6840'
4
6876'

WORST CASE, ASSUME NORMAL EFFICIENCY MOTORS: (Siemens)

30HP, HORIZONTAL, TEFC, PF = 83.4% @ 3/4 LOAD

5HP, HORIZONTAL, TEFC, PF = 82.1 % @ 3/4 LOAD

Input KVA: 460V x 40A x $\sqrt{3}$ = 31.87 KVA, 26.58KW, 17.53 KVAR

460V x 7.6A x $\sqrt{3}$ = 6.06 KVA, 4.98KW, 3.45 KVAR

37.92KVA 31.56KW, 21.03 KVAR

PF = 83.2 %

USE VOLTAGE DROP CALCS AT 80 % PF

LIMIT VOLTAGE DROP TO 3%, SINCE THIS MAY BE CONSIDERED A BRANCH CIRCUIT

#6: $V.D = 47.6A \times 6876 ft \times \frac{0.7382}{1000 A ft} = 242V$

$\% V.D. = \frac{V.D}{480 - V.D.} \times 100 = 3$ $\quad 100 V.D. = 3(480) - 3 V.D.$

$103 V.D = 1440V \quad \therefore V.D. = 13.98v$

$47.6A \times 6876 ft \times \frac{F}{1000 ft} = 13.98v \quad F = 0.0427 A ft$

RUN M-V cable to pad near Compressor + install (47.6A x 0.48KV x $\sqrt{3}$ = 39.6 KVA) XFMR

Use 75KVA, 3φ, OIL-FILLED PAD MOUNT WITH PRI. SW. + FUSES + SEC. C.B.

HDR

PROJECTS BASIN F

SUBJECT ELECTRICAL CALCS

COMPUTED MAYCOCK CHECKED BNR DATE 5-15-87 PAGE 2 OF 7

PREVIOUS INFORMATION INDICATED 13.8KV SITE DISTRIBUTION

$\therefore$ INCOMING POWER CONDUCTOR = $\frac{45KVA}{13.8KV\sqrt{3}} = 1.9$ AMPS

WORST CASE 2400V DISTRIBUTION

CONDUCTOR = $\frac{45KVA}{2.4KV\sqrt{3}} = 10.8A$

MINIMUM ALLOWABLE CONDUCTOR (NEC 310-5, 6+7; TBL 310-5) #1 (133% INSULATION LEVEL)

AMPACITY 240 AMPS (TBL. 310-81)

VOLTAGE DROP WILL BE : $R = 0.16\,\Omega/1000'$ $X = 0.045\,\Omega/1000'$

$V.D. = \sqrt{3}\,I\,(R\cos\theta + X\sin\theta)$ $\theta = \cos^{-1}0.8$

LENGTH OF RUN TO XFMR = $33' + 1920' + 1240' + 2400' + 840' + 4' = 6437'$

$V.D. = \sqrt{3}(1.9A)\left[\frac{0.16\,\Omega}{1000'} \times 6437' \times 0.8 + \frac{0.045\,\Omega}{1000'} \times 6437' \times 0.6\right]$

$= 3.3A\,[0.82_{\Omega} + 0.17_{\Omega}] = 3.3V$ $\%VD = 0.02$

VOLTAGE DROP FROM XFMR TO CONTROL PANEL

#6 COND. $\frac{47.6A \times 449' \times 0.7382V}{1000\,AFT} = 15.8V$ $\%VD = \frac{15.8V}{480V - 15.8V} \times 100 = 3.4\%$

In this case (feeder + branch ckt.) 5% V.D. is acceptable

USE 6A FUSES AT POLE

TRANSFORMER PRIMARY FUSES SIZED BY TRANSFORMER SUPPLIER TO PROTECT TRANSFORMER AGAINST SHORT CIRCUITS AND COORDINATE WITH SECONDARY CIRCUIT BREAKER

HDR

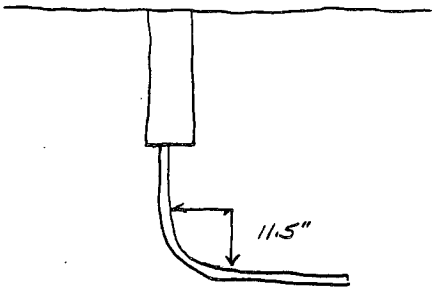
PROJECTS Basin F

SUBJECT Electrical Calculations

COMPUTED Maycock CHECKED BRL DATE 5-15-87 PAGE 3 OF 7

15kV 133% Insul. XLPE #1 OD 1.15"

bending radius = 10 x 1.15" = 11.5"



burial depth = 30"

bottom of conduit = 30" - 11.5" = 18.5"

600V USE #6 O.D. 0.35"

bending radius = 10 x 0.35" = 3.5"

burial depth = 24"

bottom of conduit = 24" - 3.5" = 20.5"

Table 430-148. Full-Load Currents in Amperes
Single-Phase Alternating-Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. Motors built for especially low speeds or high torques may have higher full-load currents, and multispeed motors will have full-load current varying with speed, in which case the nameplate current ratings shall be used.

To obtain full-load currents of 208- and 200-volt motors, increase corresponding 230-volt motor full-load currents by 10 and 15 percent, respectively.

The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120 and 220 to 240.

HP	115V	230V
⅙	4.4	2.2
¼	5.8	2.9
½	7.2	3.6
½	9.8	4.9
¾	13.8	6.9
1	16	8
1½	20	10
2	24	12
3	34	17
5	56	28
7½	80	40
10	100	50

Table 430-149. Full-Load Current
Two-Phase Alternating-Current Motors (4-Wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, and multispeed motors will have full-load current varying with speed, in which case the nameplate current rating shall be used. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given.

The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

	Induction Type Squirrel-Cage and Wound-Rotor Amperes				
HP	115V	230V	460V	575V	2300V
½	4	2	1	.8	
¾	4.8	2.4	1.2	1.0	
1	6.4	3.2	1.6	1.3	
1½	9	4.5	2.3	1.8	
2	11.8	5.9	3	2.4	
3		8.3	4.2	3.3	
5		13.2	6.6	5.3	
7½		19	9	8	
10		24	12	10	
15		36	18	14	
20		47	23	19	
25		59	29	24	
30		69	35	28	
40		90	45	36	
50		113	56	45	
60		133	67	53	14
75		166	83	66	18
100		218	109	87	23
125		270	135	108	28
150		312	156	125	32
200		416	208	167	43

Table 430-147. Full-Load Current in Amperes, Direct-Current Motors

The following values of full-load currents* are for motors running at base speed.

	Armature Voltage Rating*					
HP	90V	120V	180V	240V	500V	550V
⅙	4.0	3.1	2.0	1.6		
¼	5.2	4.1	2.6	2.0		
½	6.8	5.4	3.4	2.7		
¾	9.6	7.6	4.8	3.8		
1	12.2	9.5	6.1	4.7		
1½		13.2	8.3	6.6		
2		17	10.8	8.5		
3		25	16	12.2		
5		40	27	20		
7½		58		29	13.6	12.2
10		76		38	18	16
15				55	27	24
20				72	34	31
25				89	43	38
30				106	51	46
40				140	67	61
50				173	83	75
60				206	99	90
75				255	123	111
100				341	164	148
125				425	205	185
150				506	246	222
200				675	330	294

* These are average direct-current quantities.

Table 430-150. Full-Load Current*
Three-Phase Alternating-Current Motors

	Induction Type Squirrel-Cage and Wound-Rotor Amperes					Synchronous Type †Unity Power Factor Amperes			
HP	115V	230V	460V	575V	2300V	230V	460V	575V	2300V
½	4	2	1	.8					
¾	5.6	2.8	1.4	1.1					
1	7.2	3.6	1.8	1.4					
1½	10.4	5.2	2.6	2.1					
2	13.6	6.8	3.4	2.7					
3		9.6	4.8	3.9					
5		15.2	7.6	6.1					
7½		22	11	9					
10		28	14	11					
15		42	21	17					
20		54	27	22					
25		68	34	27		53	26	21	
30		80	40	32		63	32	26	
40		104	52	41		83	41	33	
50		130	65	52		104	52	42	
60		154	77	62	16	123	61	49	12
75		192	96	77	20	155	78	62	15
100		248	124	99	26	202	101	81	20
125		312	156	125	31	253	126	101	25
150		360	180	144	37	302	151	121	30
200		480	240	192	49	400	201	161	40

For full-load currents of 208- and 200-volt motors, increase the corresponding 230-volt motor full-load current by 10 and 15 percent, respectively.

* These values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Motors built for especially low speeds or high torques may require more running current, and multispeed motors will have full-load current varying with speed, in which case the nameplate current rating shall be used.

† For 90 and 80 percent power factor the above figures shall be multiplied by 1.1 and 1.25 respectively.

The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Table 430-152. Maximum Rating or Setting of Motor Branch-Circuit Short-Circuit and Ground-Fault Protective Devices

	Percent of Full-Load Current			
Type of Motor	Nontime Delay Fuse	Dual Element (Time-Delay) Fuse	Instantaneous Trip Breaker	* Inverse Time Breaker
Single-phase, all types				
No code letter	300	175	700	250
All ac single-phase and polyphase squirrel-cage and synchronous motors† with full-voltage, resistor or reactor starting:				
No code letter	300	175	700	250
Code letter F to V	300	175	700	250
Code letter B to E	250	175	700	200
Code letter A	150	150	700	150
All ac squirrel-cage and synchronous motors† with autotransformer starting:				
Not more than 30 amps				
No code letter	250	175	700	200
More than 30 amps				
No code letter	200	175	700	200
Code letter F to V	250	175	700	200
Code letter B to E	200	175	700	200
Code letter A	150	150	700	150
High-reactance squirrel-cage				
Not more than 30 amps				
No code letter	250	175	700	250
More than 30 amps				
No code letter	200	175	700	200
Wound-rotor —				
No code letter	150	150	700	150
Direct-current (constant voltage)				
No more than 50 hp				
No code letter	150	150	250	150
More than 50 hp				
No code letter	150	150	175	150

For explanation of Code Letter Marking, see Table 430-7(b).

For certain exceptions to the values specified, see Sections 430-52 through 430-54.

* The values given in the last column also cover the ratings of nonadjustable inverse time types of circuit breakers that may be modified as in Section 430-52.

† Synchronous motors of the low-torque, low-speed type (usually 450 rpm or lower), such as are used to drive reciprocating compressors, pumps, etc. that start unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200 percent of full-load current.

Table 310-13 (Continued)

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions	Insulation	AWG or MCM	Thickness of Insulation Mils	Outer Covering
Moisture- and Heat-Resistant Cross-Linked Synthetic Polymer	XHHW	90°C 194°F	Dry locations.	Flame-Retardant Cross-Linked Synthetic Polymer	14-10	30	None
					8-2	45	
		75°C 167°F	Wet locations.		1-4/0	55	
					213-500	65	
					501-1000	80	
					1001-2000	95	
Moisture- and Heat-Resistant Thermoplastic	THWN	75°C 167°F	Dry and wet locations.	Flame-Retardant, Moisture- and Heat-Resistant Thermoplastic	14-12	15	Nylon jacket or equivalent
					10	20	
					8-6	30	
					4-2	40	
					1-4/0	50	
					250-500	60	
					501-1000	70	
Underground Feeder & Branch-Circuit Cable-Single Conductor. (For Type UF cable employing more than one conductor, see Article 339.)	UF	60°C 140°F	See Article 339.	Moisture-Resistant	14-10	*60	Integral with insulation
					8-2	*80	
					1-4/0	*95	
		**75°C 167°F		Moisture- and Heat-Resistant			
Underground Service-Entrance Cable-Single Conductor. (For Type USE cable employing more than one conductor, see Article 338.)	USE	75°C 167°F	See Article 338.	Heat- and Moisture-Resistant	12-10	45	Moisture-resistant nonmetallic covering [See 338-1 (2).]
					8-2	60	
					1-4/0	80	
					213-500	***95	
					501-1000	110	
					1001-2000	125	

* Includes integral jacket.

** For ampacity limitation, see Section 339-1(a).

*** Insulation thickness shall be permitted to be 80 mils for listed Type USE conductors that have been subjected to special investigations.

The nonmetallic covering over individual rubber-covered conductors of aluminum-sheathed cable and of lead-sheathed or multiconductor cable shall not be required to be flame retardant. For Type MC cable, see Section 334-20. For nonmetallic-sheathed cable, see Section 336-2. For Type UF cable, see Section 339-1.

Table 310-16. Ampacities of Insulated Conductors Rated 0-2000 Volts, 60° to 90°C

Not More Than Three Conductors in Raceway or Cable or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

Size AWG MCM	Temperature Rating of Conductor. See Table 310-13								Size AWG MCM
	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	85°C (185°F)	90°C (194°F)	
	Types †RHW, †V, †VW, †MP	Types †MI, †RHW, †THHW, †THW, †THWN, †XHHW, †USE, †ZW	Types V, MI	Types TA, TBS, SA, AVB, SIS, †FEP, †FEPB, †PFA, †PFAB, †SA††	Types †RHW, †V, †VW, †MP	Types †MI, †RHW, †THHW, †THW, †THWN, †XHHW, †USE	Types V, MI	Types TA, TBS, SA, AVB, SIS, †FEP, †FEPB, †PFA, †PFAB, †SA††	
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
18	....	....	....	14	....	....	....	....	....
16	....	....	18	18	....	....	....	....	....
14	20†	20†	25	25†	....	....	....	....	....
12	25†	25†	30	30†	20†	20†	25	25†	12
10	30	35†	40	40†	25	30†	30	35†	10
8	40	50	55	55	30	40	40	45	8
6	55	65	70	75	40	50	55	60	6
4	70	85	95	95	55	65	75	75	4
3	85	100	110	110	65	75	85	85	3
2	95	115	125	130	75	90	100	100	2
1	110	130	145	150	85	100	110	115	1
0	125	150	165	170	100	120	130	135	0
00	145	175	190	195	115	135	145	150	00
000	165	200	215	225	130	155	170	175	000
0000	195	230	250	260	150	180	195	205	0000
250	215	255	275	290	170	205	220	230	250
300	240	285	310	320	190	230	250	255	300
350	260	310	340	350	210	250	270	280	350
400	280	335	365	380	225	270	295	305	400
500	320	380	415	430	260	310	335	350	500
600	355	420	460	475	285	340	370	385	600
700	385	460	500	520	310	375	405	420	700
750	400	475	515	535	320	385	420	435	750
800	410	490	535	555	330	395	430	450	800
900	435	520	565	585	355	425	465	480	900
1000	455	545	590	615	375	445	485	500	1000
1250	495	590	640	665	405	485	525	545	1250
1500	520	625	680	705	435	520	565	585	1500
1750	545	650	705	735	455	545	595	615	1750
2000	560	665	725	750	470	560	610	630	2000

AMPACITY CORRECTION FACTORS

Ambient Temp. °C	For ambient temperatures other than 30°C, multiply the ampacities shown above by the appropriate factor shown below.								Ambient Temp. °F
31-40	.82	.88	.90	.91	.82	.88	.90	.91	87-104
41-45	.71	.82	.85	.87	.71	.82	.85	.87	105-113
46-50	.58	.75	.80	.82	.58	.75	.80	.82	114-122
51-60	....	.58	.67	.71	....	.58	.67	.71	123-141
61-70	....	.35	.52	.58	....	.35	.52	.58	142-158
71-80	....	....	.30	.41	....	....	.30	.41	159-176

† The overcurrent protection for conductor types marked with an obelisk (†) shall not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper; or 15 amperes for 12 AWG and 25 amperes for 10 AWG aluminum and copper-clad aluminum after any correction factors for ambient temperature and number of conductors have been applied.

* For dry locations only. See 75°C columns for wet locations.

Notes to Tables 310-16 through 310-19

1. Explanation of Tables. For explanation of Type Letters, and for recognized size of conductors for the various conductor insulations, see Section 310-13. For installation requirements, see Sections 310-1 through 310-10, and the various articles of this Code. For flexible cords, see Tables 400-4 and 400-5.

2. Bare Conductors. Where bare conductors are used with insulated conductors, their allowable ampacities shall be limited to that permitted for the insulated conductors of the same size.

3. More than Three Conductors in a Raceway or Cable. Where the number of conductors in a raceway or cable exceeds three, the ampacities given in Table 310-16 or 310-18 shall be reduced as shown in the following table:

Number of Conductors	Percent of Values in Tables 310-16 and 310-18 as Adjusted for Ambient Temperature if Necessary
4 thru 6	80
7 thru 24	70
25 thru 42	60
43 and above	50

Where single conductors or multiconductor cables are stacked or bundled longer than 24 inches (610 mm) without maintaining spacing and are not installed in raceways, the ampacity of each conductor shall be reduced as shown in the above table.

Exception No. 1: When conductors of different systems, as provided in Section 300-3, are installed in a common raceway the derating factors shown above shall apply to the number of power and lighting (Articles 210, 215, 220, and 230) conductors only.

Exception No. 2: The derating factors of Sections 210-22(c), 220-2(a) and 220-10(b) shall not apply when the above derating factors are also required.

Exception No. 3: For conductors installed in cable trays, the provisions of Section 318-10 shall apply.

Exception No. 4: Derating factors do not apply to conductors in nipples having a length not exceeding 24 inches (610 mm).

4. Overcurrent Protection. Where the standard ratings and settings of overcurrent devices do not correspond with the ratings and settings allowed for conductors, the next higher standard rating and setting shall be permitted.

Exception: As limited in Section 240-3.

10. Neutral Conductor.

(a) A neutral conductor which carries only the unbalanced current from other conductors, as in the case of normally balanced circuits of three or more conductors, shall not be counted when applying the provisions of Note 8.

(b) In a 3-wire circuit consisting of 2-phase wires and the neutral of a 4-wire, 3-phase wye-connected system, a common conductor carries approximately the same current as the other conductors and shall be counted when applying the provisions of Note 8.

(c) On a 4-wire, 3-phase wye circuit where the major portion of the load consists of electric-discharge lighting, data processing, or similar equipment, there are harmonic currents present in the neutral conductor and the neutral shall be considered to be a current-carrying conductor.

11. Grounding Conductor. A grounding conductor shall not be counted when applying the provisions of Note 8.

CIRCUIT SCHEDULE

MARK	Ø CONDUCTORS	GROUND CONDUCTOR	CONDUIT SIZE	MARK	Ø CONDUCTOR	GROUND CONDUCTOR	CONDUIT SIZE
EQUIPMENT FEEDERS				SERVICE FEEDERS			
1	3-#12	1-#12	3/4"	25	3-#4/0	1-#2	2-1/2"
2	3-#10	1-#10	3/4"	26	2-(3-#4/0)	2-(1-#1/0)	2-2-1/2"
3	4-#10	1-#10	3/4"	27	3-#350	1-#2	3"
4	3-#8	1-#10	1"	28	2-(3-#350)	2-(1-#2/0)	2-3"
5	4-#8	1-#10	1"	29	3-#500	1-#1/0	3-1/2"
6	3-#6	1-#8	1"	30	2-(3-#500)	2-(1-#2/0)	2-3-1/2"
7	3-#4	1-#8	1-1/4"	31	3-(3-#500)	3-(1-#250)	3-3-1/2"
8	3-#3	1-#8	1-1/4"	32	4-(3-#500)	4-(1-#250)	4-3-1/2"
9	4-#3	1-#8	1-1/4"	33			
10	3-#2	1-#6	1-1/2"	34			
11	3-#1	1-#6	1-1/2"	35			
12	3-#1/0	1-#6	2"	CONTROL CIRCUIT			
13	4-#1/0	1-#6	2"	40	2-#14	IN SAME CONDUIT WITH OTHER CONDUCTORS. IN 1/2" CONDUIT IF MARK NO. APPEARS ALONE.	
14	3-#2/0	1-#6	2"	41	3-#14		
15	3-#3/0	1-#4	2"	42	4-#14		
16	3-#4/0	1-#4	2-1/2"	43	6-#14		
17	3-#250	1-#4	3"	44			
18	4-#250	1-#4	3"	45			
19	3-#350	1-#3	3"	46			
20	3-#500	1-#3	3-1/2"	47			
21				INSTRUMENTATION CIRCUIT			
22				50	2-#12, 1-#12 GRD, 3/4" C FOR 120VAC POWER DEVICE. IF DEVICE REQUIRES OTHER THAN 120VAC THEN IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO DEFINE CIRCUIT REQUIREMENT, AND INSTALL AT NO ADDITIONAL COST TO OWNER.		
23							
24				51	1-#16 TWISTED SHIELDED PAIR, 1/2" C. CIRCUIT MAKE-UP DEPENDS ON DEVICE SUPPLIED. IT IS THE CONTRACTOR RESPONSIBILITY TO DEFINE CIRCUIT REQUIREMENT, AND INSTALL AT NO ADDITIONAL COST TO OWNER.		
				52			

NOTES:

A ANY CIRCUIT NOT IDENTIFIED WITH MARK NUMBER OR DESCRIPTIVE NOTE IS A BRANCH CIRCUIT REQUIRING 2-#12, 1-#12 GRD, 3/4" C

B THIS SCHEDULE IS BASED ON THE USE OF THWN FOR CONDUCTOR SIZE NO. 8 AND SMALLER AND XHHW FOR SIZE NO. 6 AND LARGER. INCREASE CONDUIT SIZE PER N.E.C. IF OTHER INSULATION TYPE IS REQUIRED BY SPECIFICATION SECTION 16108.

C THIS IS A STANDARD SCHEDULE. SOME MARK NUMBERS MAY NOT BE USED ON THIS PROJECT.

HDR

Project DEPT. 34 Computed MAYCOCK Ckd BAL

Subject VOLTAGE DROP CALCULATION TABLE Date 7-24-86 Sht. 1 Of 1

CONDUIT SIZE / POWER FACTOR	# 12	# 10	# 8	# 6	# 4	# 3	# 2	# 1	1/0	2/0	3/0	4/0	250 MCM	300 MCM	350 MCM	400 MCM	500 MCM	600 MCM	750 MCM
80%	2.700	1.724	1.143	.7382	.4855		.3173	.2619	.2183	.1867	.1580	.1347	.1233	.1102	.1019	.0952	.0859	.0828	.0762
90%																			
95%																			

NOTE: THIS TABLE IS FOR USE WITH MAGNETIC CONDUITS ONLY VALUES IN THE TABLE ARE IN LINE TO LINE VOLTS

TO USE THE TABLE:

$$V.D. = \frac{A \times \text{VALUE FROM TABLE}}{1000 \text{ AMP FT}} \qquad A = \text{LOAD AMPS} \times \text{LENGTH OF RUN (IN AMP FT)}$$

EXAMPLE:

LOAD = 37A LENGTH OF RUN = 765'

A = 37A x 765' = 28,305 AFT

USE NO. 8 CONDUCTOR $V.D. = 1.143\,V \times \frac{28,305\,AFT}{1000\,A\,FT} = 32.35\,V$ $\%\,V.D. = \frac{32.35V}{480V - 32.35V} \times 100 = 7.2\,\%$

NOTE: LIMIT VOLTAGE DROP TO 3% OR LESS IN FEEDERS AND 2% OR LESS IN BRANCH CIRCUITS

Project Basin F	Computed DAK ckd BCL
Subject Hydraulics	Date 5/15/87 Sht. 1 Of 1

Hydraulic
Gradient Calculations:

From previous study on Basin F fluid, head loss through a 4" pipe @ 100 gpm = $\frac{4.63}{2000}$ = .0023 ft/ft
= .23 ft/100 ft

Available head from the leachate pumping locations to the surface impoundment cell = 40 ft.

Maximum run of the pipe = 920 ft

∴ Available gradient = $\frac{40}{920}$ = 0.043 ft/ft

= 4.35 ft/100 ft.

Therefore, there is plenty of slope available for overcoming friction losses in the pipe.

During design, try to maintain at least a .23 ft/100 ft slope to assure adequate flow. This will be conservative since ~~the anticipated~~ design flow is 60 gpm yet the pipe friction loss is based on 100 gpm.